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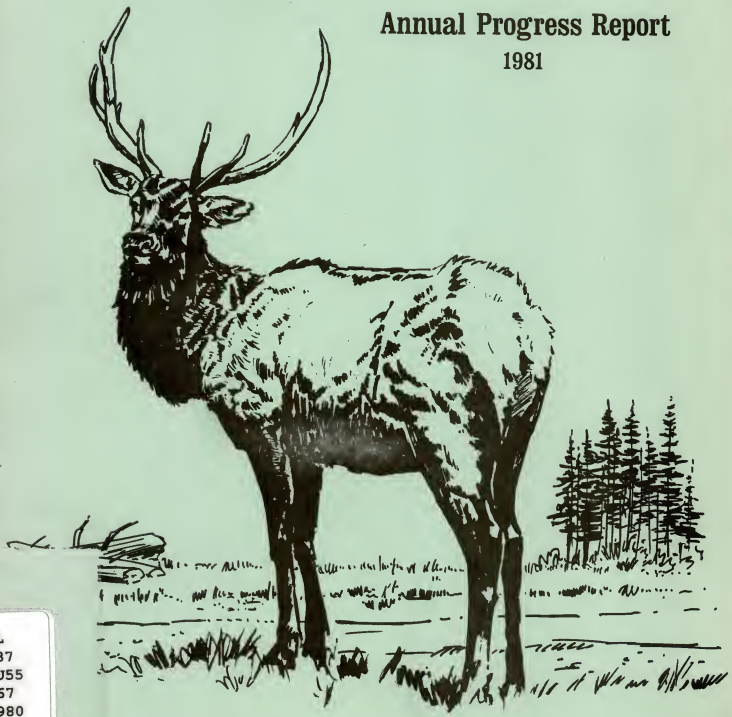
Montana Cooperative ELK-LOGGING STUDY

Annual Progress Report
1981



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MONTANA

COOPERATIVE ELK-LOGGING STUDY

Progress Report for the Period

January 1-December 31, 1980

COOPERATING AGENCIES

Region 1, U.S. Forest Service
Intermountain Forest and Range Experiment Station
Bureau of Land Management
Montana Department of Fish, Wildlife, and Parks
School of Forestry, University of Montana

STEERING COMMITTEE

Edward Schneegas, Chairman

Thadd Harrington
Don McIntosh

Eugene O. Allen

W. Leslie Pengelly

Submitted by Research Committee

L. Jack Lyon, INT, USFS, Chairman
Terry N. Lonner, F, W and P
Jack Jones, B L M
C. Les Marcum, U of M
John Weigand, F, W and P
Darrell Sall, B L M

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MONTANA COOPERATIVE ELK-LOGGING STUDY

January - December 1980

ABSTRACTS

JOB I

PROBLEM ANALYSIS AND COORDINATION

During the year, steering and research committees met twice to plan, review, and coordinate project activities. A total of 20 presentations were made by research committee personnel to various groups, organizations, and workshops. The computerized bibliography now contains 449 entries.

Long Tom Creek Study

Abstract

The 1980 field season was the third post-logging year of the study and the last full field season before final report preparation, which is expected to be completed by the end of 1982. Pre-logging years were 1972-1974 and logging years included 1975-1977. Although data analysis is far from complete, results thus far indicate that the elk not only tended to avoid the sale area and its immediate vicinity during the logging activity, but also during the three post-logging years of the study. Thirty-seven elk were fitted with telemetry transmitters during the course of the study and accounted for 2,283 relocations that were spread over an area of approximately 800 square miles. Summer home range sizes of individual elk have ranged from 1.2 mi^2 to 47 mi^2 with a very strong tendency for each elk to use the same summer and wintering area from year to year. Forage clipping sites ranged from three to seven times more productive in 1980 compared to the first time they were clipped in 1979. A brief explanation of proposed data analysis and associated computer programs is presented.

ABSTRACT

JOB II-D

CHAMBERLAIN CREEK STUDY

Objectives of this study are to describe elk distribution and elk use of several available environmental factors before, during and after logging. During 1980, Burlington Northern (BN) cutting units in and near the northeast part of the core study area (CSA) were logged. Also, spur roads to access BN cuts on the west side of Chamberlain Creek were constructed during the summer and fall of 1980. Work was not initiated on the Bureau of Land Management (BLM) Chamberlain Creek Sale until early December, when spur road construction was initiated. Road construction and logging will continue during 1981. Habitat selection, movements and distribution of elk are reported for 1980. Although there was limited logging activity in the northeast portion of the CSA, pellet count results for 1980 still complement and reinforce our predisturbance conclusion that the primary factors influencing elk habitat use and distribution patterns are a combination of weather plus vegetative composition, structure, and phenology. Yearly precipitation in 1979-80 was high, and summer elk use of the CSA was low, as predicted. The influence of logging activities on elk will be clearer as the intensity of these activities increases. Twenty-nine flights between May and December produced 438 aerial locations on 19 radio-collared female elk. The 1980 field season was the first year that radio-collared elk did not use the CSA significantly more than its availability. The CSA, however, remained important during the hunting season. Total May to December composite home range for all animals was 72 miles^2 (188 km^2) and individual home ranges ranged from 6.8 miles^2 (17.7 km^2) to 23.0 miles^2 (59.9 km^2) with a mean of 13.0 miles^2 (33.8 km^2). Elk use as related to environmental and disturbance factors varied considerably on a seasonal basis, but some May to December trends were evident. Lower elevations were used significantly less than availability but more use was made of lower elevations relative to previous years. Gentle slopes (0-15^0) were preferred. Elk use relative to aspect, horizontal configuration and distance to water varied little from availability. Elk use relative to stand composition, age and overstory canopy cover generally conformed to availability also, with the majority of locations occurring in mixed species stands, of pole to mature ages, between 25 to 75% overstory canopy coverage. PSME/CARU, ABLA/LIBO and ABLA/XETE-VASC habitat types were used significantly greater than availability. Non-forested areas, primarily pastures and hayfields, were used significantly less than availability. With respect to logging and road construction activities the majority of elk use occurred between 0.5 and 2.0 miles from the source of the disturbance. In general, elk use increased with distance from open roads. As with the pellet count results, yearly changes in habitat use and distribution by radio-collared elk appeared to be associated with direct and indirect effects of variations in annual precipitation.

ABSTRACT

JOB V-1

ELK GUIDELINES VALIDATION

During the summer of 1980, we were able to complete field validation tests of elk habitat guidelines on five study areas in western Montana. In each area, 3-4 adjacent subunits of 2000-4000 acres were evaluated for cover/forage ratio, road density, and elk pellet-group densities. Our hypothesis was that individual subunits of habitat equally available to the same elk would be utilized at the level predicted by the guidelines.

One of the questions encountered in using the guidelines involved the methods used to determine cover/forage ratios. In addition to two evaluations of the transect samples on the ground, we determined C/F ratio using PI (photo interpretation) types and one of several methods commonly used with aerial photographs. Conversion of C/F ratios to elk-habitat potential was accomplished using both the Central Zone guidelines curves and a single composite curve.

Road density effects were evaluated using two different models, and the product of habitat potential (C/F) and habitat effectiveness (roads) was taken as the prediction of relative elk use. This prediction was compared to the actual elk use recorded on pellet group transects in each subunit.

Among the methods tested, a percentage conversion on PI types, the single curve for C/F potential, and the Perry and Overly road model provided the most consistent combination of results. For the five areas tested, it is shown that subunits of habitat equally available to the same elk are utilized as predicted by the guidelines.

ELK MANAGEMENT RECOMMENDATIONS FOR THE CONSIDERATION OF LAND MANAGERS

INTRODUCTION

Certain findings appear to be firmly based and worthy of consideration. In order that management can benefit from the study effort prior to the final report, the research committee has been directed by the steering committee to formulate tentative management recommendations or guidelines based on findings-to-date.

It is not intended that these recommendations be broadly applied throughout the forests of Montana. Likewise, it is not intended that they be considered the "last word" or an attempt to dictate management practices to public agencies or private corporations. It is intended that they be considered a portion of the wildlife input that should be evaluated, along with many other values and inputs, in the planning of all timber sales and road construction projects. If a recommendation fits the situation, in an identified elk-use area, its implementation will help minimize any detrimental impact on the elk in the area. The recommendations merely represent an attempt by the study team to place significant findings in the hands of management as the research study progresses.

The following recommendations, although based on the best information presently available, are considered tentative and subject to change; the hazards of extrapolation must be recognized. They may not apply to certain local situations and literal application should not be substituted for detailed, joint discussions and on-the-ground inspections by timber and wildlife managers and other resource specialists.

SECURITY AREA RECOMMENDATION

Research Finding:

During active road building and logging, elk have responded by moving to surrounding ridgelines and further. The distance moved apparently depends on a variety of factors including size of the drainage area encompassed by logging, intensity and season of logging activities, and disturbance on the ridgelines.

Displacement of elk, which is considered temporary, has been detected as far as four miles from the area of summer logging activity. In one study, herd displacement was to an adjacent third order drainage and then beyond that drainage when the ridgeline was disturbed. In another investigation, displacement was down a ridgeline for two miles through undisturbed timber and over a point. In both cases, topographic features provided a line-of-sight barrier between elk and the logging activity.

Recommendation: Planning for timber sales in elk summer range should include provision of a security area immediately adjacent to the disturbed area during the active logging and/or road building period. It is also suggested that disturbances with heavy equipment on elk summer range be completed in the shortest possible time and, if possible, during periods of the year when elk are not present.

Discussion: Security for elk is still an undefined concept, but it appears that an area adequate to reduce long distance displacement of animals by timber sale activities should satisfy the following minimum criteria:

-- it must be adjacent to and easily reached by elk dispersing from the disturbed area, and the intervening ridgeline must be protected from all mechanical activities.

-- it should contain a fairly large acreage of forest cover at the head of a drainage. The particular acreage required will depend on cover quality, but the areas available to elk in one study were about 5,000 acres, and this size also approximated the average summer range (June-August) used by several radio instrumented animals in another study.

Application of the security area concept on the ground must be based on individual situations as they exist. There is no way to specify an exact acreage required for all elk everywhere.

Several available security areas are considered far superior to a single area, and where consecutive timber sales progress from one drainage to the next, it is suggested that activity be confined to a single drainage at a time with completed sales being converted to security areas as quickly as possible. While the data for predicting duration of disturbance effect (i.e. how long before the elk return to a logged area) is still incomplete, the initial indications are that total time of disturbance is more important than the severity of disturbance. Intensive activity in a single season is far less detrimental than a low level of activity over several seasons.

HABITAT TYPE-MOIST SITE RECOMMENDATION

Research Finding:

Within the various study areas, findings-to-date indicate that during the summer months (June-September) elk prefer those sites at the head of drainages bordering streams or marshy meadows, or occupying moist swales or benches. All of these sites are characterized by their close proximity to areas where water is present, on or near the surface, for all or part of the summer period. Both east and west of the Continental Divide these sites are usually found within the *Abies lasiocarpa* habitat type series. East of the Continental Divide, the dominant vegetative components of these sites are Subalpine fir, Whitebark pine, spruce, or combinations thereof. These sites are usually found within the *Abies lasiocarpa/Calamagrostis canadensis, Abies lasiocarpa (pinus albicaulis)/Vaccinium*

scoparium, Abies lasiocarpa/Vaccinium scoparium (Thalictrum occidentale phase), and *Abies lasiocarpa/Luzula hitchcockii* habitat types as described by Pfister, et al. (1975). In western Montana these moist sites are generally found within the more hydric parts of the *Abies lasiocarpa/ Luzula hitchcockii (menziesia* phase),*Abies lasiocarpa/Clintonia uniflora, Abies lasiocarpa/Menziesia ferruginea,* and the *Abies lasiocarpa/Galium triflorum* habitat types described by Pfister, et al. (1975).

Recommendation: Two general types of summer range situations exist in Montana. The first type occurs where moist sites are found in close proximity to each other, and in combination with other habitat components they comprise a rather large area, which is heavily used by elk. Another type of situation exists, where moist sites are not in close proximity with one another, but evenly distributed over the summer range. While this latter situation may support a large number of elk in total, each moist area may be used by relatively fewer animals. These two situations are not mutually exclusive, so both types can occur on portions of the same summer range. Where the first situation exists, an area large enough to maintain the overall integrity of the habitat components to be managed should be determined by an on-the-ground inspection by land and wildlife managers and other appropriate resource specialists. A similar recommendation to protect moist sites which are relatively far apart but evenly distributed over a summer range, as well as a security zone of cover around each site, may be impractical. However, it should be recognized that continual loss of these small units and their juxtaposition in the forest could in time have a substantial adverse impact on a local elk herd. Therefore, as many as possible of these sites should be identified and withdrawn from treatment, along with a peripheral zone to provide continuous cover with the uncut forest. New or planned roads passing near these sites should be closed to summer-fall vehicular traffic, except perhaps for light intermittent administrative use, following logging in the area. Roads which already occur near moist areas of either type described above should be closely evaluated for travel restrictions.

Discussion: Moist sites (wet sedge meadows, bogs, seeps, etc.) have been identified as a very important component of elk summer range especially when these sites occur within the *Abies lasiocarpa* climax series.

Preferred elk summer range exists when these moist sites are interspersed with other necessary habitat components including a diversity of timber types and densities, and perhaps dry broken or open parks, especially near drainage heads or other topographic entities where these conditions are found.

In terms of the biology of elk, sites near water are important because the forage they produce is heavily utilized by elk prior to the breeding season. Other studies indicate that nutrition obtained by the animals during this period is a significant factor in reproduction. Generally, west of the Continental Divide early to mid-seral stages of the habitat types named above produce more forage. However, mature stands on moist sites also provide important cover, and removal of such stands may result in a decline or loss of elk use in the area.

ROAD LOCATION RECOMMENDATION

Research Finding:

Location and density of roads, and the use made of those roads, may be disturbing to elk depending on intensity, type, and season of use. Elk travel routes normally cross ridges through saddles and are usually easy to identify. When these saddles are opened up they tend to be avoided as crossing places for elk. Disturbance by road construction or hunting season traffic has resulted in declines or elimination of elk use in such places. Elk have indicated a preference for crossing ridges in sections where visibility is relatively low and security relatively high, often where dense timber is present. Alteration of such crossing areas can be especially critical during the hunting season.

Recommendation: During the location and design of transportation systems, existing elk movement patterns and probable elk crossing areas should be identified and provisions made to provide security for unimpeded movement. Where possible, several alternate routes should be considered. Primary considerations should be given to:

a. maintaining frequent dense cover areas adjacent to the road;
b. avoiding saddles or low divides frequented by elk for crossing ridges between drainages;
c. maintaining cover at places where game trails cross roads;
d. utilizing a low standard slow speed, single track road that lays lightly on the ground in important elk areas; and
e. road right-of-way slash should be disposed of so as to not inhibit elk movement.

HABITAT TYPE-COVER TYPE RECOMMENDATION

Research Finding:

While the habitat type classification system gives a reasonable description of forest community composition and ecological potential, the structural characteristics, or cover type, can vary within habitat types by location and over time. Also, seral stages in different habitat types may be structurally similar. Elk use of cover types within and between habitat types is often specific, changing in both space and time during summer and fall. For example, moist sites may be highly preferred from June through September but avoided in October and November while the relatively advanced seral stages and the more dense stands of timber may not be as important June through August as in the fall months.

Recommendation: Findings of this study indicate that plant community structure, or cover type, is often a more important factor than community composition, or habitat type, in determining elk use during summer and fall. Management efforts based on what's going to be there (habitat type) should be well coordinated with an awareness of what's there (cover type) and a knowledge of spatial and temporal differences in elk use within and between habitat types.

Discussion: Preserving or maintaining the interspersion, diversity, and juxtaposition of various habitat types and their successional stages or cover types cannot be overemphasized as an important elk management tool on important elk spring, summer, and fall range. When an attempt is made to quantify elk use-habitat type relationships it is very difficult to differentiate between the importance of individual habitat types and the importance of the overall interrelationships of these types with one another, not to mention the various stages of development or cover types within each habitat type. Important or key areas for elk must be identified before or during the planning and implementation of silvicultural practices.

CLEARCUTS RECOMMENDATION

Research Finding:

Graphic analyses of the number of elk pellet groups found inside clearcuts in eastern and western Montana have identified seven different variables that influence elk use of openings. All are important in some degree, but relative importance can vary depending on the environment available to elk and elk behavioral patterns associated with their environment.

In eastern Montana, for example, tree cover occupies a smaller proportion of the winter range and there is a more distinct separation between winter and summer ranges. Elk make relatively greater summer use of clearcuts at higher elevations as compared to western Montana where some elk remain on the winter range year around.

Throughout Montana elk range, slash within the opening and dead and down timber in the surrounding uncut forest reduced elk use. A preference for small openings was indicated, particularly in western Montana, but cutting units as large as 100 acres may be acceptable under some circumstances.

Elk response to the growth of vegetation inside an opening differs between eastern and western Montana. The differences could be related to vegetation palatability but are more probably determined by the habitual feeding pattern of animals. Where new growth consists of both trees and shrubs and elk feed on browse, elk use of openings increases until vegetation is at least four feet high. Where new growth is mostly trees and elk feed primarily on grasses and forbs, elk use of openings declines as vegetation heightincreases. As a corollary to this indicated preference for openings lacking tall cover, eastern Montana elk responded to additional security provided by good cover adjacent to the opening and, further, demonstrated a substantial positive response to openings without motor vehicle access.

Recommendation: On the basis of available data, it is not possible to demonstrate that clearcuts in any configuration are clearly beneficial to elk. Neither is it possible to demonstrate detrimental effects if the openings satisfy certain criteria:

(1) Slash cleanup inside clearcuts should reduce average slash depth below 1.5 feet. Slash in excess of 1.5 feet will reduce elk use by more than 50 percent.

(2) Small openings appear to be preferred, but openings up to 100 acres may be acceptable where the adjacent forest is relatively free of understory debris and security is adequate.

(3) Security cover is required if elk are to enter any opening. In western Montana, some cover is provided by vegetation growth as the opening becomes older; but in eastern Montana elk prefer young openings and security should be provided by designing clearcuts so that the best available cover occurs at the edges. As a corollary, thinning adjacent to clearcuts is not recommended.

(4) Additional security, which will significantly increase elk use of openings in eastern Montana, can be provided with appropriate road closures.

ROAD CLOSURE RECOMMENDATION

Research Finding:

Two phases of the project involved area closures that restricted motor vehicles to a few selected roads during the hunting season.

The Judith Road Closure Study indicated that travel restrictions did not change elk distribution or temporal distribution of hunters. Apparently this area closure was not necessary to "protect" elk where escape cover was adequate and well distributed (at least 2/3 cover to 1/3 open). Hunters spent more time walking; consequently, they reported seeing and killing more elk under the restrictions than during the unrestricted seasons. Their unsolicited comments showed a preference for limited access because of the "higher quality" hunt it afforded.

The Ruby Road Closure Study, on the other hand, showed that area closures can cause significant changes in elk distribution and hunter use of the area. This area was characterized by a relatively open, broken forest with gentle terrain and easy access (1/3 cover to 2/3 open). During seasons of restricted travel, elk stayed in the restricted area longer and in greater numbers than during preclosure seasons. This resulted in a greater season-long uniformity (but not total amounts) of hunting pressure, elk sightings, and elk harvest. Hunters also spent more time walking during the restriction period. A trend toward these same changes was noted in the unrestricted travel zone of this study area. Most hunters interviewed felt that the area closure had increased the quality of their hunt.

Recommendation: Elk management goals and objectives should be clearly defined before imposing travel restrictions, being especially cognizant of the following:

I. Restrictions will:
   1. increase the time spent walking by hunters, and as a result:

a. increase the number of animals seen.
b. possibly increase the kill.
2. generally be accepted as providing a higher quality hunt.
3. make retrieval of killed animals more difficult.

II. Where cover is good (at least 2/3 of total area) and well interspersed, restrictions will probably have little effect on elk distribution.

III. Where cover is poor (1/3 or less of total area) restrictions will:
1. reduce harassment and emigration of elk.
2. probably reduce the early elk harvest, but increase the uniformity of harvest throughout the season.

Discussion: Road density and pattern, including off-road travel, play an important role in determining the security level an area provides to elk during the hunting season. An area with sparse cover and low road density may provide as much security as the same sized area with heavy cover but with high road density. For example, in the Ruby portion of this study the security level was significantly increased by reducing the road density and by eliminating off-road travel. Road density and cover quality are *both* important when considering adequate elk security during the hunting season.

Also, road closures in areas that change elk distribution in space and/or time must also change elk distribution in the adjacent area(s) (an elk can't be in two places at the same time). Therefore, closures may benefit hunters in one area at the expense of hunters elsewhere.

WINTER RANGE RECOMMENDATION

Research Finding:

Elk on winter range have been shown to prefer dense timber stands and larger trees for bedding cover. These bedding sites are usually in close proximity to a feeding area such as a south-facing slope with a good stand of browse or perennial grass. Timbered areas which received moderate to heavy elk-bedding use prior to logging were not used for bedding during winters following heavy selection logging. Elimination of these preferred bedding sites can subject elk to a decrease in energy intake and an increase in energy output because of increased travel between suitable bedding and feeding sites, lowered insulating value of bedding cover because of loss of large trees, and use of inferior food sources closer to new bedding sites.

Recommendation:

Because of the relative importance of productive elk winter range and the narrow margin for error, any contemplated modification should be planned on a site by site basis with primary emphasis on maintaining adequate thermal cover adjacent to productive forage areas.

On important and already well used winter ranges, the probability of improvement is usually minimal. Where winter range quality is declining or is already suboptimum, especially on shrub ranges, several management options offer possibilities for enhancing winter range.

Timbered areas adjacent to primary foraging areas should be managed to provide thermal cover. The presence of larger trees in a multistory stand is desirable.

Where forage conditions are poor, the timber overstory can be removed in small patches to enhance forage production. The design and layout of these openings should be planned so that adjacent forest cover on benches and finger ridges will provide thermal cover and bedding sites. Slash cleanup should be relatively complete and logging should be scheduled outside the winter period.

ELK-CATTLE RECOMMENDATION

Research Finding:

Findings from investigations to determine seasonal elk distribution have indicated that the presence and distribution of domestic cattle has substantially influenced the distribution of elk on summer range. Systematic observation revealed a significant tendency for elk to avoid cattle. Movement of cattle into areas being used by elk caused displacement of the elk into areas where cattle had not been or would not be.

Recommendation: Road construction and/or other associated timber harvest activities occasionally "open up" new areas for grazing or alter existing cattle grazing allotments on elk summer ranges, increasing the potential for elk-cattle interaction in such areas. The effect of every proposed timber sale on elk and livestock management objectives and programs should be evaluated. If potential elk-livestock conflicts are identified as a result of proposed timber harvest, the conflict should be resolved on a case-by-case basis.

JOB I

PROBLEM ANALYSIS AND COORDINATION
PROGRESS REPORT FOR PERIOD JANUARY 1-DECEMBER 31, 1980

INTRODUCTION

The objectives of this job are to identify the basic conflicts between timber harvest and elk ecology in the various forest types of Montana, and to plan and coordinate research efforts.

With the compilation of this report, the Montana Cooperative Elk-Logging Study has completed ten years of field investigation. Currently, three studies remain active, but analyses and publication continue in several other jobs.

Job I	Coordination. On-going for the life of the project.
Job II-A	Burdette Creek-Deer Creek. Completed.
Job II-B	Long Tom Creek. Final year of study completed. Analyses and manuscripts in process.
Job II-C	Sapphire Mountains. Completed.
Job II-D	Chamberlain Creek. Road-building completed; logging in progress.
Jobs III-A-1 and A-2	Judith and Ruby road closures. Completed.
Job III-B	Disturbed areas. Completed. One manuscript published in 1980.
Job IV	Spotted Bear. Completed.
Job V	Elk/Timber Management Guidelines. Five study areas were evaluated.

COMMITTEES

The project Steering Committee for 1980 included the following members:

Region 1, USFS	Edward Schneegas, Chairman
Intermountain Forest and Range Experiment Station	Thadd Harrington
Bureau of Land Management	Don McIntosh
Montana Department of Fish and Game	Eugene O. Allen
School of Forestry, University of Montana	W. Leslie Pengelly

The project Research Committee for 1980 included the following members:

Intermountain Forest and Range Experiment Station	L. Jack Lyon, Chairman
Montana Department of Fish and Game	John P. Weigand
Bureau of Land Management	Jack Jones, Darrel Sall
School of Forestry, University of Montana	C. Les Marcum
Region 1, USFS	Not represented

ACTIVITIES

Meetings. The Steering and Research Committees met twice in 1980--April 23 and August 14 in Helena. The August meeting included on August 15 tour of the Elkhorn Mountains wildlife management area on the Helena National Forest.

Presentations. Various members of the Research Committee attended other meetings or workshops to discuss results of the study. The following presentations were made:

January 8	Interagency Meeting, Luby Bay, Idaho	Lyon
February 7	Sigma XI, Missoula	Marcum,
February 7	Sigma XI, Missoula	Loftsgaarden
February 14	Kootenai-Salish Community College	Lemkuhl
February 20	Elk guidelines meeting, Kalispell	Lyon
February 28	Western States Elk Workshop, Cranbrook, BC	Lonner
March 25	North American Wildlife Nat. Res. Conference, Miami	Lyon
April 16	Deerlodge National Forest, Wildlife Workshop, Fairmont	Lyon
April 16	Deerlodge National Forest, Wildlife Workshop, Fairmont	Lonner
May 2	Target Range School	Edge
May 14	BIA Workshop, Missoula	Lyon
May 26	Colorado State University seniors, Missoula	Lyon
July 14	YCC, Missoula	Marcum
August	BN Land Managers, Kalispell	Hicks
August 18	Land Stewardship Meeting, Divide	Lonner
October 1	University of Montana, wildlife class	Marcum
October 15, 16	Elk guidelines meeting, Helena	Lonner
October 16	Missoula Exchange Club	Marcum
December	BN Land Managers, Newport, Washington	Hicks
December 9	Wildlife Subcommittee of RAD, Bozeman	Lonner

Publications

Lonner, Terry N. 1980. Why do we want elk, anyway? Proc. West State's Elk Workshop, Cranbrook, BC

Lyon, L. Jack. 1980. Coordinating forestry and elk management. Trans. No. Amer. Wildl. and Nat. Res. Conf. 45:278-287.

Marcum, C.L. and D.O. Loftsgaarden. 1980. A non-mapping technique for studying habitat preferences. J. Wildl. Manage. 44(4):963-968.

Research Committee. 1980. Montana Cooperative Elk-Logging Study, Annual Progress Report, Jan. 1-Dec. 31, 1980. 84 pp.

Other Activities

We have no count of the number of times the Cooperative Elk-Logging Slide Tape was used in Region 1. However, we received a report from Roger Bumstead that the slide series was shown at least 176 times in USFS Region 3 (Albuquerque).

Terry Lonner reports no change in the computerized bibliography. A total of 449 citations are now included. Instructions for using this bibliography, key word lists, loan of the magnetic tape, or hard copy are available (cost about $18). Contact:

Terry Lonner
Montana Department of Fish, Wildlife, and Parks
Box 5, MSU Campus
Bozeman, Montana 59717

Submitted by L. Jack Lyon

JOB II-B
LONG TOM CREEK STUDY
PROGRESS REPORT FOR THE PERIOD
JANUARY 1, 1980 - DECEMBER 31, 1980

Introduction

The objectives of this study are to determine the environmental requirements of elk and the effects of logging on an elk population in the scattered forest type of Long Tom Creek in southwestern Montana. On the ground field work has been conducted from June or early July-October each year, 1972-1980. Aerial surveillance has occurred at least once a month since the beginning of the study to locate radioed elk and/or measure the general elk distribution and herd composition. The years 1972, 1973, and 1974 were pre-logging years even though some minor road construction began in the extreme southern portion of the study area in 1974. Logging activity primarily began in the summer of 1975 and continued through 1976 and 1977, so these years were considered logging years. The years 1978-1980 were considered the post-logging phase of the study, although some minor logging activity occurred during the fall of 1978. Since the new logging road was built, it has been closed (with a gate) to motorized public access. However, from July 15 through September 1, 1980, the road was opened to the public for firewood gathering. All other road systems in and adjacent to the study area have remained open since the beginning of the study.

The 1980 field season was the last full field season before final report preparation, but some field work will be conducted during the summer of 1981. The final report is expected to be completed by the end of 1982. Consequently, this report is only cursory in nature, with some preliminary results and a brief discussion of major analytical methods planned to be used for data interpretation.

Description of the Study Area

Long Tom Creek, located about 25 miles southwest of Butte, Montana, is a side drainage of Jerry Creek which flows southerly and empties into the Big Hole River near the village of Wise River (Fig. 1). Elevations range from 7,000 to 9,100 feet with the Continental Divide forming the north boundary of the study area. The Long Tom Creek-Upper Johnson Creek study area comprises 36 square miles and consists of a series of heavily timbered ridges of moderate relief. A variety of cover and habitat types are represented including lodgepole pine, Douglas-fir, subalpine fir, whitebark pine, Engelmann spruce, and combinations thereof as dominant overstory species. The area is interspersed with numerous small, wet sedge meadows and bogs, parks, rocky ridges and open, south-facing sagebrush and grass-covered slopes. Clearcut logging has occurred in the head of Jerry Creek to the east and in lower Johnson Creek to the south and southwest. The only public vehicle access to the area is by 4-wheel drive from the east and northeast during periods of relatively dry road conditions. The study area is a portion of Hunting Unit 319 and is mostly on the Beaverhead National Forest with a small portion to the North located on Deerlodge National Forrest land.

Figure 1. Vicinity of the Long Tom Creek Study area.

Methods

As during previous field seasons, elk use of the study area was determined in 1980 primarily from "elk sign" recorded while periodically and systematically walking 62 miles of foot routes that were established during the first field season in 1972. During the 1980 field season, the route system was walked four times between June 26 and October 7. In previous years, the number of times the route system was walked and used for data analyses were three in 1972, six in 1973 and 1974, four in 1975, five in 1976, and four in 1977 through 1979. Pellet group counts combined with other elk sign observed (tracks, bed sites, animal observations, wallows, and rubbed trees) were used as the primary method to sample elk use of the study area via the route system. Duplication of recording the same elk use from one replication to another has been avoided as much as practical.

A detailed explanation of the route system and how elk use was recorded while walking the routes was presented in the 1976 progress report (Lonner, 1976). Several other measurements have been made of the immediate area sampled by the route system. Measurements and their completion status are presented in Table 1.

Vegetation was clipped in July, 1980 from ten sites to record production and compare it with some of the productivity results from Hammond's work in 1979. These sites will again be clipped in July, 1981.

Radio telemetry work was continued to gather detailed information on distribution and movements of radio-equipped elk. A total of eleven cow elk were tracked during the 1980 field season. Of the elk tracked, one was collared in 1973 and recollared during 1979, one was collared in 1974 and recollared in 1978, one was collared in 1975 and recollared in 1979, four were collared in 1978, three in 1979, and one in 1980. Further information on these elk is presented in Table 2. As in previous years, all active radios were tracked at weekly intervals from mid-April into December, but no tracking was done through the winter months as in other years. This involved twenty-five flights in a Super Cub from May 1, 1980 to December 31, 1980. Transmitters were put on using a helicopter and capture gun during early spring.

Triangulation was again used to gather around-the-clock information on daily movements of individual radio-collared elk. This was accomplished by making bihourly (every two hours on the two hours) relocations during four triangulation sessions ranging in length from eight to fifty hours. This involved three or four fixed base stations located on high points in or near the study area. These base stations were equipped with null-peak antenna systems purchased from AVM Instrument Company of Champaign, Illinois. A further explanation of this system is described by Pac in the 1978 Proceedings of the Montana Chapter of the Wildlife Society's Annual Meetings.

Hunter questionnaires were again filled out on opening day of the general big game season at six check stations located near the Long Tom Creek study area. Similar surveys were conducted in 1972 through 1979.

Table 1. List of variables measured or to be measured for some or all of the 700 segments composing the foot route system in the Long Tom Creek study area.

Elk use (pellet groups and general impression)[1]
Deer use (pellet groups, observations, tracks)[1]
Cattle use (droppings, observations, tracks)[1]
Forage use[1]
Wetness type[1]
Wetness degree[1]
Segment length[2]
General cover type[2]
Habitat type[2]
Density of trees by species and by dbh and height classes[2]
Canopy coverage[2]
Tree stand age[2]
Distance to closest cutting unit and/or new mainline road[2]
Sight distance[2]
Downfall[2]
Ground cover or understory vegetation (largely explained by habitat type)[2]
Aspect[2]
Configuration[2]
Topography[2]
Slope (%)[2]
Size of opening (park, broken park, clearcut) segment passes through (if applicable)[2]
Security index for primary foraging areas (all segments but timbered ones)[3]
Forage quality and quantity measurements of general vegetation types[3]
Indices of interspersion, diversity, and homogeneity for each segment of the route system[3]
UTM coordinates for the center of each segment[2]

[1]Measured each time segment is surveyed.
[2]Measurements are completed.
[3]Measurements are partially complete.

As in 1974 and 1976 through 1979, elk use adjacent to the proposed or new logging road was measured by 27 six foot wide belt transects. These transects were established in 1974 and are approximately 1/4 mile apart, extending 200 yards (paces) on each side and perpendicular to the road. This sampling system primarily records fall use (persistent pellet groups) made by elk during the previous fall(s). These transects will be measured one more time during the 1981 summer.

Analysis of data will involve many of the statistical programs already existing and available at the Montana State University Computing Center. Several other programs have been developed or are in the process of being developed to assist with data analysis and interpretation. A major effort will be made to measure elk distribution relative to habitat interspersion and man-caused alteration. The computer program being developed to assist with this

Table 2. Some general statistics and seasonal home range calculations from telemetry work done on 29 elk in management unit 319 from spring, 1973 through December, 1980.

Radioed Elk Channel No. & Year Tracked	Sex	Age	Winter Range Where Collared	Spring May 1-June 15				Summer June 16-Sept.30				Fall Oct. 1-Dec. 1				Winter Dec. 2-April 30				Spring-Fall May 1-Dec. 1			
				No.[1]	Area[2]	On Per[3]	SD[4]	No.	Area	On Per	SD	No.	Area	On Per	SD	No.	Area	On Per	SD	No.	Area	On Per	SD
178-78	M	2	Fleecer	6	28.4	5	12.7	15	20.9	5	5.2	7	24.1	4	8.5	8	2.6	5	2.2	28	72.6	7	9.3
178-79				6	31.1	6	13.3	14	22.3	5	5.6	5	19.6	4	11.2		Elk dead			25	91.2	7	10.6
274-74	F	Ad	Fleecer	5	10	3	5.4	8	1.4	4	1.4		< 3	Fixes						15	18.1	5	5.7
274-75				5	11.8	5	5.7	20	10.8	7	3.5	7	7.2	4	4	5	.5	3	1.3	32	35.1	7	6.8
274-76				6	12.7	4	5.8	19	5	7	3.2	9	6	6	3.1	9	16.2	6	7.3	34	19.5	6	4.3
274-77				6	4.3	4	3.1	12	6.3	7	3.6	7	6.9	5	4.9	7	10.4	5	4.6	25	18	9	4.9
274-78				6	17.9	4	7.9	14	3	7	2.7	7	1.6	4	1.9	8	2.3	5	2.2	27	25.2	6	4.6
274-79				7	18.1	5	6.5	16	6.9	7	3.1	8	8.6	6	4.4	7	8.9	5	5.2	31	29.4	12	5.6
274-80				5	3.3	5	3.1	13	4.6	6	2.2	6	16.8	4	7		No Flights Made			24	30.4	7	6.1
278-78	F	6	Fleecer	6	1.8	5	3.2	21	33.5	9	10.4	7	3.1	3	2.4	8	3	6	2.7	34	39.2	9	9.3
278-79				7	36.2	5	16.9	14	47.4	5	14.2	7	9.6	4	4.8	7	10.8	6	5.4	28	71.4	6	14.3
278-80				5	45	4	15.8	13	35.3	7	15.6	6	9.3	5	7.4		No Flights Made			24	78.2	7	16.5
376-76	F	1	Fleecer	7	19.7	6	6.3	16	24	6	4.5	9	10	4	3.8	9	5.9	5	4.6	32	41.1	6	5
376-77				6	2.9	5	3	14	8	7	3.1	8	1.2	4	1.4	7	2	6	2.1	28	10.8	7	3.4
376-78				6	2.3	5	2.4	16	15	7	4.1	7	5.4	6	3.1	3	.3	3	6.7	29	18.5	8	3.8
476-76	M	2	Fleecer	7	11.8	4	5.8	17	16.9	6	6.1	9	9.2	7	5.7	9	2.7	5	1.9	33	26.6	8	6.6
476-77				6	2.7	5	3.3	14	14.1	6	5	5	.5	5	1.7		Elk dead			25	20.7	5	4.8
479-79	F	8-10	Fleecer	7	17.6	5	17.6	15	6.2	8	3.2	8	5.1	6	4.5	7	10.0	6	6	30	25.7	9	5.6
479-80				5	2.4	5	2.3	13	10	5	3.8	6	5.8	5	5.1		No Flights Made			24	22.3	6	5.5
578-78	F	6	Fleecer	6	2.8	4	5.4	15	20	6	4.8	7	6.2	4	3.6		Elk dead			28	27.5	9	5.5
579-79	M	2	Fleecer	6	77	6	23.4	6	9.0	4	5.7		Lost signal after 8/11/79										
675-75	F	2	Fleecer	5	1.1	4	3.1	15	6.9	7	2.8	7	6.3	5	4.3	5	.8	3	1.6	27	17.2	5	3.9
675-76				6	3.9	6	3.1	15	5.3	6	2.7	9	2.9	6	2	9	8.4	5	3.9	30	10.9	7	2.8
675-77				6	6.7	5	3.6	4	2.5	4	2.8		Radio quit----------										
678-78	F	7	Fleecer	6	8.3	5	4.8	15	8.8	6	3.4	7	4.8	4	4.2	3	5.4	7	4.4	28	27.3	6	4.8
678-79				7	5.8	6	4.9	14	7.3	6	3.2	7	2.3	4	3.2	7	26.7	5	8.1	28	21.1	9	4.7
678-80				5	2.3	5	4.7	13	27.3	5	5.6	6	2.3	6	4.6		No Flights Made			24	48.4	7	6.5
778-78	F	2	Fleecer	6	4.6	6	4.5	16	30.5	7	5.5	7	9	4	3.8	7	2.4	4	2.2	29	38.9	6	5.4
778-79				7	9.7	4	8.1	13	3.3	4	1.8		Radio quit----------										
878-78	F	6	Fleecer	6	7.1	3	5.5	15	5.2	5	2.7	7	2.5	4	3.3	8	14.6	5	9.2	28	23.5	5	4.5
878-79				7	5.6	6	3.5	15	8.8	6	3.6	7	14.1	5	4.8	7	56	4	10.3	29	35.8	8	5.1
878-80				5	.6	5	3.1	13	10.1	5	3.5	6	16.6	4	7.8		No Flights Made			24	43.8	5	6.0
1117-77	F	7	Fleecer	6	9.8	4	5.6	15	14.7	7	5.8	8	12	5	6.7	7	10.4	5	4.7	29	21.7	5	6
1117-78				6	6.5	4	3.7	9	2	4	2.1		Radio quit----------										
1175-75	F	Ad	Fleecer	5	1.2	3	2.8	19	9.9	8	3.8	7	10.6	6	6.1	6	1.8	4	2.1	31	30.1	8	7.2
1175-76				6	13.9	5	6.6	18	4.5	10	3.2	9	7.3	6	3.2	9	12.2	5	6	33	25.9	9	5
1175-77				6	10.7	4	6.9	15	12.2	6	4.8	3	.5	3	1.6		Elk dead			24	21.1	7	6.2
1177-77	F	7	Fleecer	4	7.1	3	8.6	13	6.5	8	3.7	7	11.4	4	10.5	5	14.1	4	11.4	24	106	6	11.1
1177-78				3	13.3	3	10.5	17	42.7	4	7.3	7	8.3	4	5.9	8	45.9	6	12.5	27	101	6	8.9
1179-79	F	6-8	Fleecer	6	23	4	13.4	15	12.7	8	4.1	7	7.8	4	10.3	7	6.3	4	10	28	50.3	11	11
1179-80				5	30.4	4	10.9	13	18.4	6	6.0	6	5.0	5	12		No Flights Made			24	63	7	10.3

Table 2. Continued.

Radioed Elk Channel No. & Year Tracked	Sex	Age	Winter Range Where Collared	Spring May 1-June 15				Summer June 16-Sept.30				Fall Oct. 1-Dec. 1				Winter Dec. 2-April 30				Spring-Fall May 1-Dec. 1			
				No.[1]	Area[2]	On Per[3]	SD[4]	No.	Area	On Per	SD	No.	Area	On Per	SD	No.	Area	On Per	SD	No.	Area	On Per	SD
1278-78	F	5	Fleecer	6	9.3	3	5.5	15	16	5	3.9	7	3.7	4	3.7	8	5.2	5	2.7	28	37.8	7	5.2
1278-79				7	18.1	4	7.1	15	7.1	6	2.9	7	5.7	5	3.6	7	16.3	6	7	29	28.4	8	6.6
1278-80				5	2.0	5	3.1	14	8.6	6	3.9	6	1.2	5	2.4	No Flights Made				25	10.5	7	4.1
2057-77	M	2	Big Hole	4	1.6	4	2.5	14	44.5	7	10.6	4	4.7	3	3.5	Elk dead				22	160	7	19.3
4579-79	F	6	Fleecer	7	1.1	5	1.4	15	3.5	7	2.1	7	3.3	5	2.6	7	1	5	1.4	29	8	8	2.7
4579-80				5	1.4	4	2.1	13	15.5	6	5.9	6	1.9	5	2.1	No Flights Made				24	26	6	4.7
Total Fleecer - 1975				15	22	7	4.5	54	22.2	11	5.7	21	22.8	9	5.3	16	2.1	7	1.8	90	48.4	11	7.1
Total Fleecer - 1976				32	40.4	6	6.6	85	42.8	8	6.3	45	35.9	8	5.5	45	35	11	6.2	162	56.8	9	6.4
Total Fleecer - 1977				44	111.8	9	10	101	398	11	24	42	347	6	22.8	26	78.7	7	8.5	177	468	11	22.1
Total Fleecer - 1978				63	239	6	12.7	168	220	7	11.4	70	175	12	13.6	66	68.7	14	9.8	301	309	10	12.4
Total Fleecer - 1979				74	266	12	17.9	152	299	8	17.6	63	143.6	12	15.4	56	95.4	14	10.8	279	283	18	16.2
Total Fleecer - 1980				40	215	6	16	105	236	14	17	48	118	7	15.4	No Flights Made				193	277	12	16.7
Overall Fleecer - 1974-1980				307	345	12	15.5	703	535	14	16.4	295	708	8	16.4	202	185	13	11	1305	740	16	16.4
175-75	F	6	High Rye	5	7.9	4	5.7	12	28.1	5	5.4	6	4.5	4	3.1	4	1.7	4	2.3	23	63.5	5	6.8
175-76				6	3.9	5	5.3	15	18.1	6	4.6	9	28.2	5	6.5	9	8.2	4	4.8	30	44.5	5	5.9
175-77				5	5.4	4	4.4	Radio quit→															
473-73	F	Ad	High Rye	6	2.3	4	2.5	11	1.2	7	1.3	Radio quit→											
473-79				7	1.8	5	2.3	15	2.2	8	1.9	7	3.6	4	2.6	7	2.6	6	2.8	29	16.1	10	5.5
473-80				5	6.9	4	4.3	13	2.9	7	2.3	6	8.6	4	3.8	No Flights Made				24	21.3	6	4.9
575-75	F	Ad	High Rye	4	.5	4	1.3	13	12.7	6	4.5	7	14.3	5	6.3	6	3.8	5	3	24	43.3	6	8.5
575-76				6	25.3	4	10.2	16	13.1	6	4	9	20.2	5	5.9	9	32.4	5	9.3	31	54.7	7	6.3
575-77				5	6.6	3	4.2	14	12.4	5	4.2	4	3.4	4	3	Radio quit→				23	27.7	7	5.4
875-75	F	Ad	High Rye	6	0	2	1.5	15	12.8	7	3.9	7	3.7	3	2.8	6	4.4	4	3	28	15.5	10	4
875-76				6	15.5	5	5.9	15	22.2	8	5.4	9	19.5	6	6	5	5.8	5	4.7	30	36	9	5.8
875-77				Only Located Once				14	21.1	4	4.6	5	7.4	4	5.6	Radio quit→							
875-79				7	2.8	5	5.5	14	12.4	6	3.9	7	7.9	5	3.9	7	1	6	2.5	28	21.7	7	4.6
875-80				5	3.3	4	4.9	13	15.1	5	4.4	6	2.8	5	3.2	No Flights Made				24	23.1	6	4.3
975-75	F	2	High Rye	5	2.6	4	2.4	16	8.3	8	3.5	7	1.6	4	2.4	6	5.9	4	3.5	28	30.1	10	5.8
975-76				6	2.1	4	2.4	15	8.9	6	2.9	9	9.3	7	4.9	9	12	5	4.7	30	17.6	9	3.9
975-77				5	.8	4	1.6	13	5.1	5	2.3	8	12.7	6	5.1	Radio quit→				26	18.5	7	3.8
979-79	M	3	High Rye	6	6.8	6	6.3	15	7.1	7	4.1	5	13.5	4	5.4	Elk Dead				26	29.2	8	5
1277-77	F	Ad	High Rye	6	1.5	4	4.3	14	5.1	8	3.0	8	12.1	6	4.9	7	3	4	2.1	28	13.1	7	4
1277-78				6	4.3	6	13.3	18	32.1	9	10.5	7	7.8	5	3.6	8	2.7	7	2.7	31	40	8	10.6
1277-79				7	8.9	6	4.5	16	12.1	5	3.8	7	10.6	4	4.5	4	.8	4	1.5	30	28.9	8	5.6
1378-78	F	1	High Rye	6	5.3	3	3.3	15	18.1	5	6.3	7	25.1	4	6.4	8	3.2	4	2.3	28	46.5	7	6.1
1378-79				7	11.1	4	4.3	11	10.7	6	3.8	Radio quit→											
1475-78	F	Ad	High Rye	4	12.3	4	7.3	Could not locate→								5	2.6	5	2.8	--	--	--	--
580-80	F	Ad	High Rye	5	7.1	3	9.2	13	11.3	8	4.1	5	29	4	8.8	No Flights Made				23	48.9	6	7.
Total High Rye - 1975				20	17.4	6	4.6	46	52.4	10	7.3	27	40.1	9	7.5	22	8.2	8	3.3	103	102	8	8.1
Total High Rye - 1976				24	65	7	9	82	97.1	11	7	36	88.6	9	8.2	32	58.1	7	7.1	121	113.4	13	7.8
Total High Rye - 1977				21	67.8	7	8.9	55	65	10	6.6	25	76	6	8.1	Only One Elk Tracked				77	95.2	11	8.6
Total High Rye - 1978				16	53.3	6	10.5	33	82.4	8	9.6	14	33.1	5	6.9	21	12.1	7	3.8	59	98	6	9.7
Total High Rye - 1979				34	73	10	9.0	71	40.9	14	6.0	26	41.4	7	5.9	18	8.4	6	3.9	133	81	12	7.1
Total High Rye - 1980				15	37	6	9.2	39	45	8	6	17	45	8	6.9	No Flights Made				71	84.6	9	7.2
Overall High Rye - 1973-1980				143	140	12	10.0	340	127	9	7.4	148	126	9	7.8	94	75.5	9	5.8	605	181	10	8.4

[1]Number of relocations.
[2]Area in square miles based on connecting perimeter locations to form a polygon.
[3]Number of relocations used on perimeter to form a polygon for home range area calculations.
[4]Standard diameter in miles.

is called GEOSCAN. Major habitat features such as vegetation cover types, topography (using contour lines), roads, and human activity centers such as campgrounds and summer homes will be input using a digitizing tablet. Elk use expressed by telemetry relocations, general observations, and transect surveys will then be used and the relative composition of the environment surrounding each point will be measured. The measurements will then be compared to measurements made from several hundred random points. The program will allow scanning around all points of interest using any radius desired. This exercise should help us further understand in what combination and proportion certain environmental features are preferred by elk in a free ranging wild condition.

Elk Distribution and Response to Logging

The total summer-early fall elk use of the study area varied during the study (Fig. 2), but the general distribution of this elk use remained similar from year to year (Fig. 3). Much of the variation in elk use that did occur was probably attributable to cattle grazing, sampling error, weather and exogenous variables that always seem to plague such research efforts. The logging activity and associated habitat alteration also had its effect on the elk use of the area.

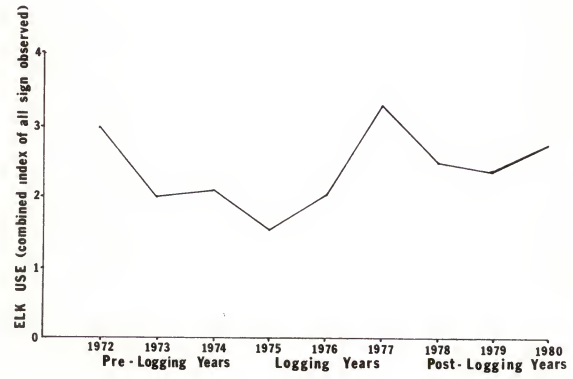

Figure 2. Yearly summer-early fall elk use of the Long Tom Creek study area as determined by the foot route system.

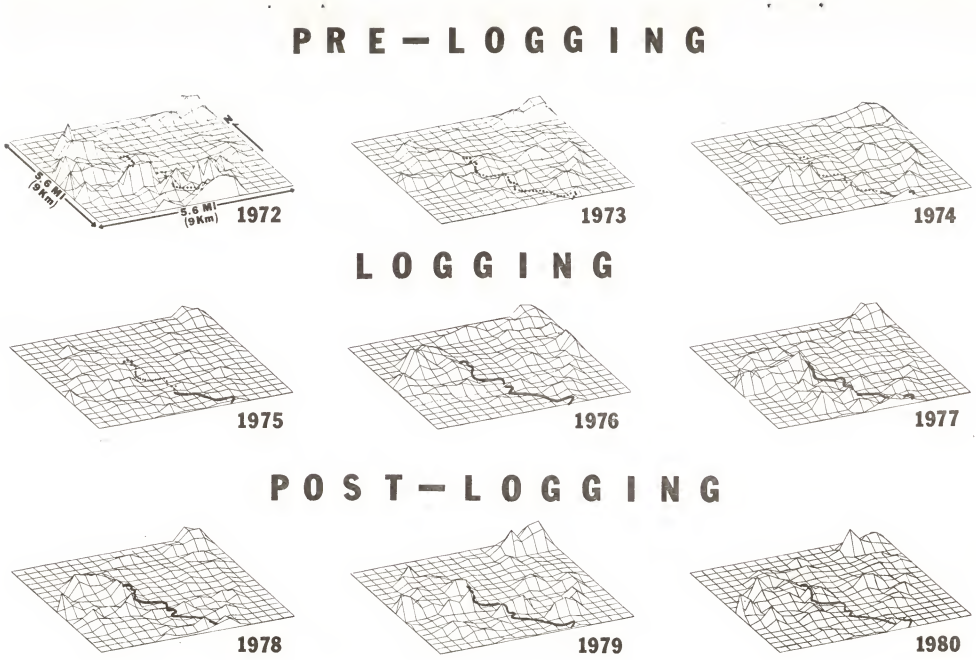

Figure 3. Three dimensional displays of summer-early fall elk use in the Long Tom Creek study area for 1972-1980. The elk use is expressed as mountainous relief and the new road is represented as either proposed (dotted line) or under construction or completed (solid line).

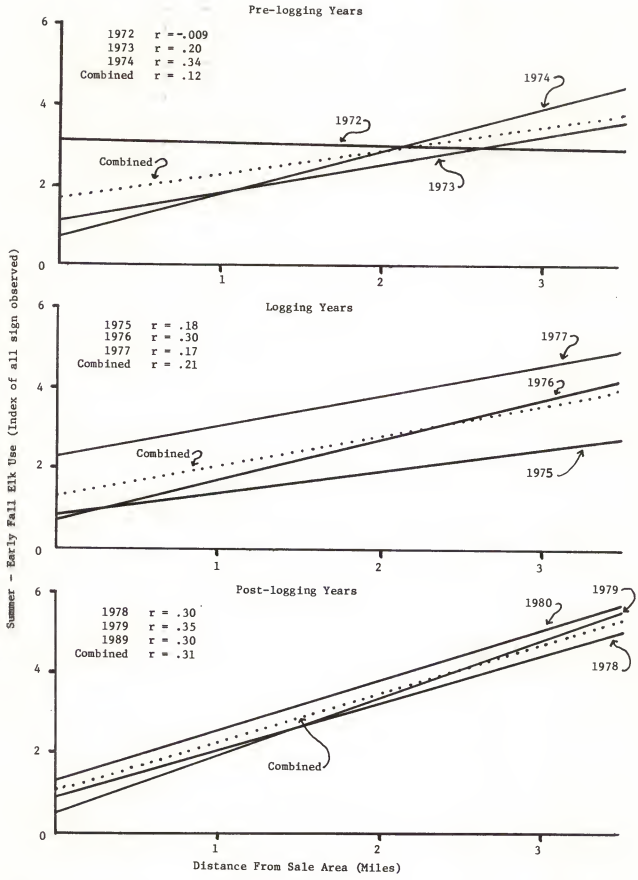

Figure 4. Comparison of linear regression lines and correlations (r) between summer-early fall elk use and distance from the Long Tom Creek logging sale for 1972 through 1980 as determined by the foot route system.

Analyses to date indicates a negative response by the elk to the logging activity and alteration of the area. The elk did show a tendency to avoid the sale area before any logging occurred, but more so during active logging with an even stronger tendency to avoid the sale area after logging (Fig. 4). The majority of this avoidance reaction seemed to occur within a mile of the sale area both during and after logging.

Data collection for fall elk use of the study area will not be complete until during the 1981 field season when pellet groups deposited during the 1980 fall will be recorded along the established foot routes. Fall elk use immediate to the sale area (within about one eighth mile) as measured by the twenty-seven road cross transects has been determined through the fall of 1979. Results of these surveys show a continuous decline in elk use since 1973 (Fig. 5).

Even though data analysis is far from complete, these results are substantial evidence that the elk not only tended to avoid the sale area and vicinity during the logging activity, but also during the three post-logging years of the study.

Telemetry Results

Thirty-seven elk were fitted with telemetry transmitters during the course of the study and accounted for 2,283 relocations. Twelve of these elk wintered on the High Rye Winter Range and involved 744 relocations, while the remaining 25 were from the Fleecer Winter Range area and totaled to 1,539 relocations. The spring-fall area of distribution for elk from both of these winter ranges has thus far proven to overlap considerably, although the Fleecer elk have been the most far ranging with a total polygon area of 822 square miles compared to 181 square miles for the High Rye Elk (Fig. 6).

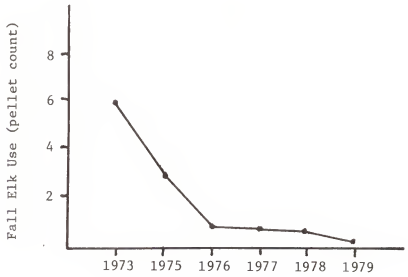

Figure 5. Comparisons between years of fall elk use immediately adjacent to the main logging road associated with the Long Tom Creek timber sale.

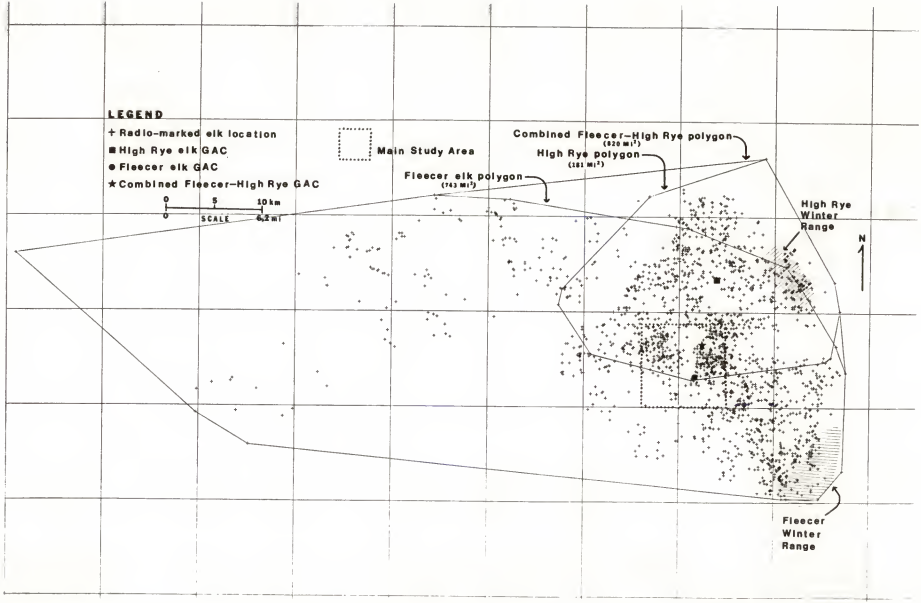

Figure 6. All relocations of radio-equipped elk determined between spring 1973 and December 1980 in game management unit 319 with area polygons and geographic activity centers (GAC) summarizing relocations of elk from two different wintering areas.

Seasonal fidelity of twenty-three radio-collared elk tracked for at least two field seasons was highest for the summer season (June 16 - September 30) with each individually collared elk demonstrating a marked desire to summer in the same area year to year (Table 3). The average distance between geographic activity centers between years ranged from .2 to 2.9 miles with an overall average of 1.1 miles. The tendency for these elk to winter in the same area year to year has also been very strong with no interchange of winter ranges yet observed.

As Table 2 shows, seasonal home range sizes have varied substantially, especially between elk year to year. The home range area based on connecting perimeter locations to form a polygon has ranged from near 0 to 77 mi^2 for the spring season (May 1 - June 15), 1.2 - 47 mi^2 for the summer season (June 16 - September 30), .5 - 29 mi^2 for the fall season (October 1 - December 1), .3 - 56 mi^2 for the winter season (December 2 - April 30), and 8 - 160 mi^2 for the spring-fall seasons combined. Home range sizes expressed by the standard diameter method were not as varied as the polygon method, since this method of measuring home range size is not as sensitive to relocations remote from the majority of activity. (One standard diameter is the diameter of a circle which has the geographic activity center (GAC) as its center with presumably at least 68 percent of the animal's activity occuring in that circle, Hayne, 1949 and Harrison, 1958.) This measurement resulted in ranges of 1.3 - 23.4, 1.3 - 15.6, 1.4 - 12, 1.3 - 12.5 and 2.8 - 19.3 miles for spring, summer, fall, winter, and spring through fall seasons, respectfully (Table 2).

Forage Production

Forage clipping sites ranged from three to seven times more productive in 1980 compared to 1979 with an overall average of 3.7 times more production (Fig. 7). Most of this difference was likely due to spring growing conditions as influenced by precipitation. Precipitation totaled to 10.2 inches for April-July 1980 while for this same time during 1979 it totaled to only 4.1 inches.

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Harrison, J. L. 1958. Range of Movement of some Malayan rats. J. Mammal. 38(3):190-206.

Hayne, D. W. 1949. Calculation of size of home range. J. Mammal. 30(1):1-18.

Table 3. Comparison of average distances between summer (6/15-9/30) Geographic Activity Centers (GAC) for all elk radio-tracked for at least two years in Fish, Wildlife and Parks Management Unit 319.

	Elk ID.	Sex	Age	No. GAC's and Years Tracked		Average Distance Between all GAC's		Standard Deviation	
						KM	Miles	KM	Miles
FLEECER HERD	274	F	Ad.	7	1974-80	1.2	.8	.74	.46
	675	F	2	3	1975-77	.6	.4	.47	.29
	1175	F	Ad.	3	1975-77	1.0	.7	.78	.49
	376	F	1	3	1976-78	1.3	.4	.65	.4
	476	M	2	2	1976-77	.4	.2	-	-
	1117	F	7	2	1977-78	4.7	2.9	-	-
	1177	F	7	2	1977-78	2.8	1.7	-	-
	178	M	2	2	1978-79	2.7	1.7	-	-
	278	F	6	3	1978-80	3.2	2.0	1.37	.85
	678	F	7	3	1978-80	2.1	1.3	.9	.56
	778	F	2	2	1978-79	1.7	1.0	-	-
	878	F	6	2	1978-79	.8	.5	-	-
	1278	F	5	3	1978-80	1.3	.8	.66	.41
	479	F	9	2	1979-80	1.7	1.0	-	-
	1179	F	7	2	1979-80	1.7	1.1	-	-
	4579	F	6	2	1979-80	1.7	1.1	-	-
HIGH RYE HERD	473	F	Ad.	3	1973 & 1979-80	1.0	.6	.57	.35
	175	F	6	3	1975-77	2.6	1.6	1.37	.86
	575	F	Ad.	3	1975-77	.9	.5	.32	.2
	875	F	Ad.	5	1975-77 & 1979-80	1.5	1.0	.67	.42
	975	F	2	3	1975-77	1.1	.7	.51	.32
	1277	F	Ad.	3	1977-79	4.6	2.9	3.45	2.14
	1378	F	1	2	1978-79	.6	.4	-	-
	Total Average					1.7	1.1	-	-

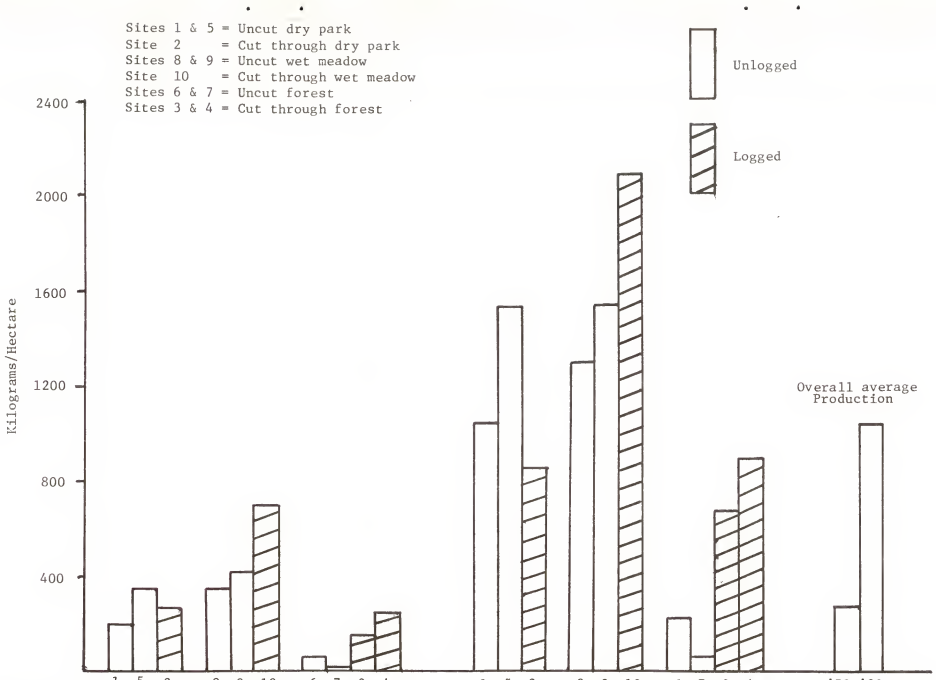

Figure 7. Forage production as determined by clipping 10 sites in late July during 1979 and 1980 in the Long Tom Creek study area.

Lonner, T. N. 1976. Job II-B, Long Tom Creek Study. pp 25-72. In: Ann. Prog. Ppt. of Mont. Coop. Elk-Logging Study, 1976.

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Submitted by,

Terry N. Lonner

JOB II-D

CHAMBERLAIN CREEK STUDY

Progress Report for the Period January 1 - December 31, 1980

INTRODUCTION

Generally, the objectives of this study are to describe elk distribution and elk use of several available environmental factors before, during and after logging in Chamberlain Creek in western Montana. The study has been conducted by personnel of the School of Forestry, University of Montana since 1975, under contract to the Bureau of Land Management. Additional funding is provided through the McIntire-Stennis Federal Forestry Program administered through the Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana; and by the Timber and Land Department of the Burlington Northern Company.

During 1980, the Burlington Northern cutting units in and near the northeast part of the core study area (CSA) were logged. Because of poor lumber market conditions, work was not started on the BLM Chamberlain Creek Sale until early December, when spur road construction was initiated. Spur roads were also constructed on the west side of the CSA during the summer and fall of 1980. Road construction and logging will continue during 1981.

Graduate student John F. Lehmkuhl left the project in April 1980 to take a position with the U.S. Forest Service in Albuquerque, New Mexico (Region III). His thesis, covering results obtained from 1977, 1978 and 1979 telemetry data, will be completed by April 1981. The telemetry work was continued by graduate student W. Daniel Edge, who began his studies in April 1980.

STUDY AREA

Location and Physiography

The study area is located in the northern Garnet Mountains of western Montana approximately 35 miles (56 km) east of Missoula (Fig. 1). Radio-collared elk have used an area of approximately 72 mi^2 (186 km^2). The core study area (CSA), where logging is planned, is 5800 acres (2350 ha) in size.

Elevations range from approximately 3800 feet (1160 m) along lower Elk Creek to 6860 feet (2090 m) at Chamberlain Mountain. Elevations within the CSA range from 4400 feet (1340 m) to 6800 feet (2070 m).

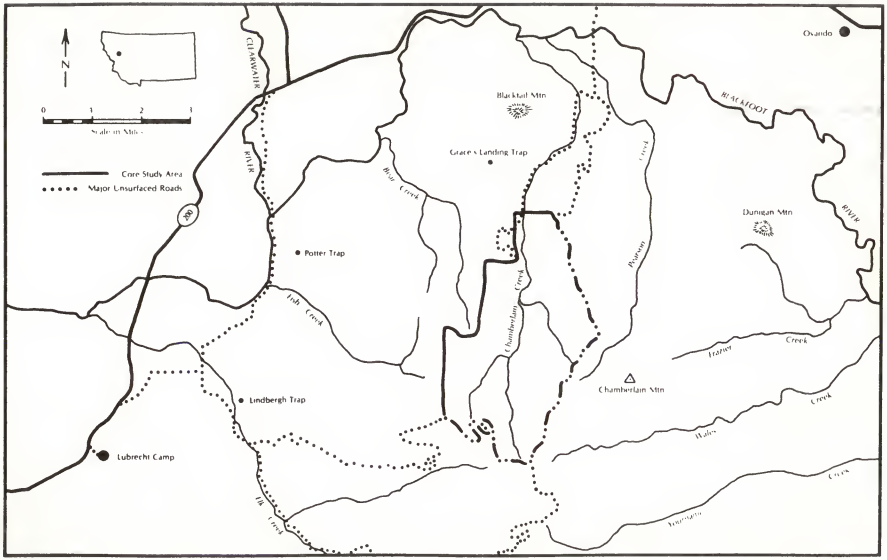

Figure 1. Map of the study area.

Land-Use Practices

Prior to, and during the first years of this study human impact on the CSA was minimal. Two small clearcuts occurred in the southwest corner of the area, and a larger clearcut was located at the northwest corner. However, the main portion of the CSA had never been logged and was essentially roadless. Construction of the main contract road into the area was initiated during 1978, and completed in fall 1979. The first new logging in the CSA was done in the northeast corner on Burlington Northern lands during 1980. Because of inaccessibility, only light to moderate livestock grazing occurred in the CSA. The area was fenced during 1976 and 1977 to prevent an increase in livestock use as logging roads made the area more accessible; and, thus, to avoid the problems of trying to distinguish the influences of livestock grazing on habitat selection by elk from the influences of logging.

Extensive logging occurred throughout the study area, outside of the CSA, 40-50 years ago. Within the past 20 years, remnant and second-growth timber has been widely logged throughout Bear Creek, upper Fish Creek, Little Fish Creek, and Lower Chamberlain Creek. Generally, the logging has been some form of partial cutting, with some clearcuts in Little Fish and Bear creeks. Cattle use areas north and southwest of the CSA throughout the spring to fall seasons, whereas horses are grazed in the Fish and Bear creek drainages. Agricultural lands for hay production occur along lower Elk, Pearson, and Chamberlain creeks and on the flats between the Potter Trap and the Blackfoot River.

Recreational use is limited almost entirely to big game hunting in the fall. The study area is part of the Blackfoot Special Management Area which is closed to vehicles during the hunting season.

Of the 5800 acres (2350 ha) in the CSA, approximately 4000 acres (1620 ha) are National Resource Lands managed by the Bureau of Land Management (BLM), and 1800 acres (730 ha) are private lands (Burlington Northern, Inc.). The remainder of the general study area is, for the most part, privately owned (approximately 80 percent by Champion International Co.), with some sections owned by the State of Montana.

Vegetation

Forests of the study area are within the Douglas-fir (Pseudotsuga menziesii) and subalpine fir (Abies lasiocarpa) climax series of Pfister et al. (1977). Almost 450 sites within the study area were habitat typed by elevation and aspect to build a habitat type distribution model (Fig. 2). Estimates of the proportions of different habitat types within the study area are presented with the estimates of elk use of habitat types in the telemetry results section.

Descriptions of the vegetation in the CSA, and estimates of proportions of the CSA in each type were reported by Scott (1978) and Marcum et al. (1979).

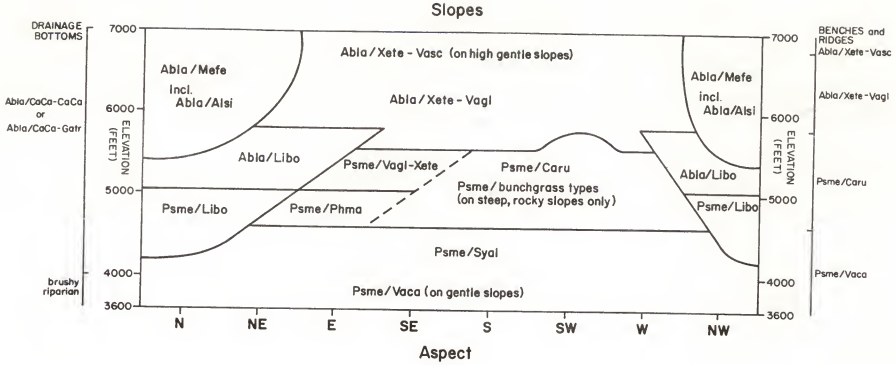

Figure 2. Habitat type distribution model for the entire study area.

METHODS AND MATERIALS

Habitat Description

Fifteen permanent belt transects, 4 feet (1.2 m) wide, were established diagonally across the core study area (CSA) at approximately one-quarter mile (400 m) intervals. Each transect was divided into a series of segments, not less than 50 feet (15 m) and not greater than one-eighth mile (200 m) long, according to changes in cover and/or habitat type (Pfister et al. 1977). Each segment is categorized by a variety of environmental variables. Estimates of habitat availability in the CSA are obtained by summarizing the transect segments by the different environmental components.

To provide estimates of habitat availability for telemetry studies, an annual sample of random points within the area used by radio-collared elk is taken. Each point is described, using maps and aerial photographs, in terms of several habitat factors and disturbance relationships.

Elk Habitat Selection and Use and Distribution and Movements

Pellet counts are now conducted twice yearly, once in late June and once in late August, along transects in the CSA. Pellet groups are aged as described by Lyon (1973a), and are cleared from the transects during each count.

Weekly aerial locations of radio-collared elk are obtained from mid-May through December to obtain elk habitat use and movements data, both inside the CSA and on adjacent lands. Ground telemetry is used to supplement aerial locations for determining elk movements and distribution.

Vegetative and Photo Plots

Permanent vegetation plots were established in eleven representative stands in proposed cutting units. The nested plot sampling system used was described by Lyon (1973b) and has been used in other investigations of the Montana Cooperative Elk-Logging Study. Pre-logging results were reported in August 1978 (Marcum et al. 1978). These plots will be remeasured after logging to document changes which occur. Also, representative permanent photographic plots have been established along pellet transects for pre- and post-logging visual reference.

Statistical Procedures

The proportion of availability of a given habitat factor, based on transect segment length or random point sampling, was compared to the proportion of elk use based on pellet counts or telemetry locations (Marcum and Loftsgaarden 1980). The significance of the difference

between proportions was determined by a Z-test (Snedecor and Cochran 1967). Datum analysis was accomplished using the University of Montana DECSYSTEM-20 computer and a series of standard statistical programs, Statistical Package for the Social Sciences (SPSS, Nie et al. 1975).

The following convention was used to indicate the statistical significance of the difference between the proportion of availability of a habitat factor and the proportion of elk use of that factor: + or - indicates elk use significantly greater or less than availability, $p \leq 0.05$; ++ or -- indicates a significant difference with $p \leq 0.01$; lack of a sign indicates no significant difference.

RESULTS

Results reported here are primarily from data collected during 1980. However, the results of the study to date will be considered in the discussion section. Data collected during previous years of this investigation are presented in previous annual reports, and in theses by Scott (1978) and Lehmkuhl (1981). Pellet and telemetry results are treated separately because they are not strictly comparable due to differences in technique, area and time periods considered, and sampling intensity per unit area.

Pellet Count Results

Transects have been cleared of all elk pellets during each survey since the August count of 1978. Since then, old and very old (OVO) pellet groups counted during the spring have been used to provide an estimate of fall elk use for the preceding year. Sample sizes for fall 1978 and 1979 were 355 and 734 respectively. Only fresh and new (FN) pellet groups were used for spring and summer estimates of elk use. Sample sizes for spring counts were 77 during 1980, 118 during 1979, 82 during 1978, and 139 during 1977. The spring 1977 data were revised because of mistakes made in classifying pellet group ages on some transects. These data give fairly reliable estimates of spring distribution and habitat use by elk, but the total count will not be used to predict future spring use. Summer sample sizes were 193 during 1980, 420 during 1979, 380 during 1978, 600 during 1977, and 201 during 1976.

Because of these substantial differences in sample size between counts, care must be used in interpreting the tabular data which are reported here in terms of proportions of elk use for various environmental categories. Changes in proportions within a category from one count to another do not necessarily reflect changes in the actual number of pellet groups counted for that category.

Elk distribution. The CSA was divided into 11 subunits based on topographic and vegetative homogeneity to identify yearly and seasonal shifts in elk distribution (Fig. 3). Percentages of elk use compared to availability for CSA subunits for fall 1979, and spring and summer 1980 are shown in Table 1. Areas of actual elk use and non-use during the same seasons are shown in Figures 4 through 6. Figures 7 and 8 are composite maps of the consistency of elk use in the CSA for 4 springs and 5 summers.

Table 1. Percentages of availability and elk use related to CSA subunits

		% Elk Use		
		(OVO Pellets)	(FN Pellets)	
Sub-unit	% Availability	Fall 1979	Spring 1980	Summer 1980
1	8.7	9.5	++27.3	7.8
2	9.0	5.3	6.5	5.2
3	9.0	8.2	- 0.0	10.4
4	6.4	3.5	- 0.0	5.7
5	2.5	1.4	0.0	4.1
6	3.2	2.5	0.0	2.6
7	1.2	0.1	0.0	0.0
8	15.6	++32.1	++50.6	15.0
9	14.9	16.9	- 5.2	++29.0
10	15.8	-- 8.1	10.4	14.0
11	13.7	12.4	- 0.0	- 6.2

Most fall 1979 elk use of the CSA was in subunits 8 and 9. These two subunits made up 30.5% of the CSA, but received 49.0% of the fall elk use. Elk use was significantly greater than availability in subunit 8, and significantly less than availability in subunit 10. Spring elk use occurred primarily on the lower elevation subunits 1 and 8. Summer elk use was generally well distributed throughout the CSA, but use was significantly greater than availability in subunit 9, and significantly less in subunit 11. During summer months, relative elk use increased in mesic subunits (3, 4, 5, 9, 10, and 11) when compared to relative spring use.

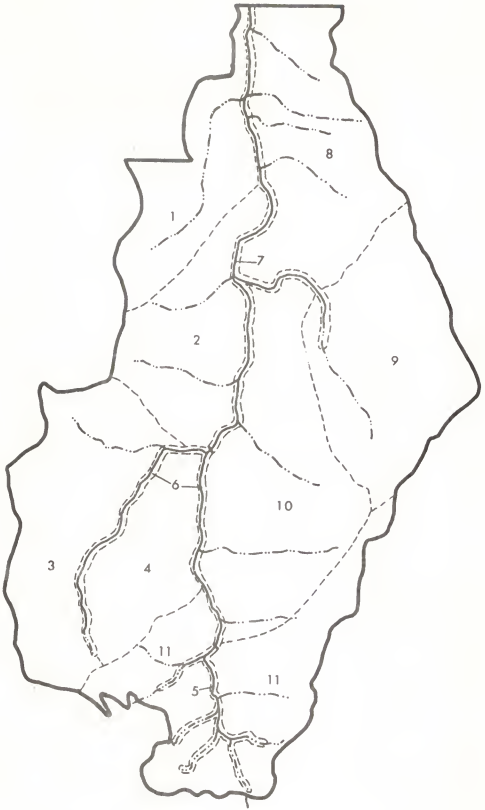

Figure 3. Map of subunits in the core study area.

Figure 4. Areas of elk use and non-use in the CSA during fall 1979.

Figure 5. Areas of elk use and non-use in the CSA during spring 1980.

Figure 6. Areas of elk use and non-use in the CSA during summer 1980.

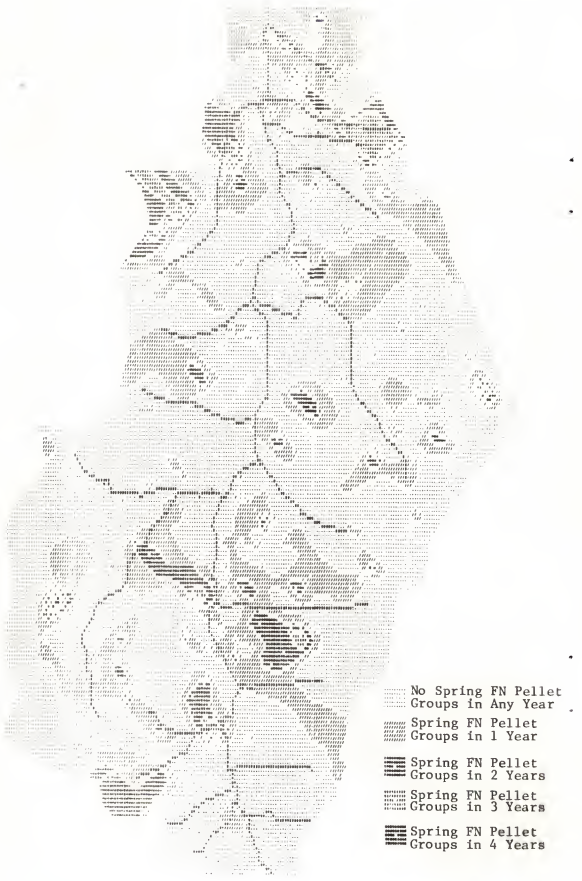
No Spring FN Pellet Groups in Any Year
Spring FN Pellet Groups in 1 Year
Spring FN Pellet Groups in 2 Years
Spring FN Pellet Groups in 3 Years
Spring FN Pellet Groups in 4 Years

Figure 7. Consistency of CSA elk use for springs, 1977-1978-1979-1980.

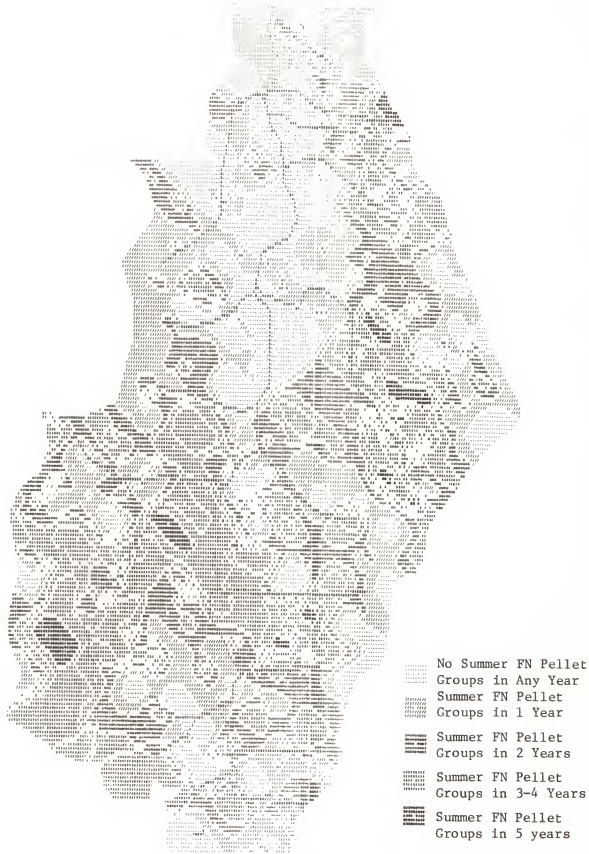
No Summer FN Pellet Groups in Any Year
Summer FN Pellet Groups in 1 Year
Summer FN Pellet Groups in 2 Years
Summer FN Pellet Groups in 3-4 Years
Summer FN Pellet Groups in 5 years

Figure 8. Consistency of CSA elk use for summers, 1976 through 1980.

Topographic factors. Elk use and availability by elevation, slope, aspect and topography are presented in Tables 2 through 5. During spring 1980, elk use was greatest within the 5100-5600 feet (1550-1700 m) elevation interval, and was significantly greater than availability. Spring elk use at higher elevations was significantly less than availability. Otherwise, for all seasons considered, use was greatest at 5700-6200 feet (1740-1890 m) elevation, on gentle (0-15°) slopes, on westerly aspects and on mid-slopes. During summer 1980 use of gentle slopes was significantly greater than availability. Except for the selectivity shown in elevation categories during spring, and for slope during summer, the elk were generally well distributed and not very critical in their choice of topographic habitat factors.

Elk use was less than availability on areas greater than 450 yards (410 m) from water (Table 6) during all three seasons, significantly so during fall 1979 and spring 1980. Use of areas near water was high, but not significantly different from availability.

Vegetative factors. Tables 7 through 12 show elk use and availability percentages for vegetative habitat components. Elk primarily used moderately dense lodgepole pine (Pinus contorta) stands during fall 1978. Use was significantly greater than availability in dense Douglas fir-western larch (Pseudotsuga menziesii - Larix occidentalis) stands, old successional stage stands, understories dominated by bunchgrasses (Festuca idahoensis) and Agropyron spicatum), and the PSME/CARU-AGSP habitat type. Fall 1979 elk use was significantly less than availability in medium to large lodgepole pine stands, young stands, understories dominated by grouse wortleberry (Vaccinium scoparium), and the ABLA/XETE-VAGL and ABLA/XETE-VASC habitat types.

During spring 1980 elk use was significantly greater than availability for relatively open areas (0-25% canopy cover, >100 yard sight distance, and old successional stage), and for the PSME/FEID habitat type (with bunchgrass dominated understories). However, use was also significantly greater than availability for dense Douglas fir - western larch stands. Conversely, use was significantly less than availability for intermediate (50-100 yard) sight distances, lodgepole pine stands, young successional stages, understory dominants of mesic sites, and the ABLA/XETE-VAGL and ABLA/MEFE habitat types.

Elk primarily used dense (>75% canopy cover) stands, with intermediate sight distance, young medium to large lodgepole pine, in subalpine fir (Abies lasiocarpa) habitat types during summer 1980. No vegetative habitat category was used significantly greater than availability, but areas with moderate (25-75%) overstory canopy coverage and old successional stages were used significantly less than availability.

Table 2. Percentages of availability and elk use related to CSA elevation.

Elevation feet (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
4,500-5,000 (1,370-1,520)	9.1	13.4	20.8	4.7
5,100-5,600 (1,550-1,700)	22.5	26.9	++53.2	20.2
5,700-6,200 (1,740-1,890)	50.2	46.1	--19.5	53.9
6,300-6,800 (1,920-2,070)	18.2	13.6	-- 6.5	21.2

Table 3. Percentages of availability and elk use related to CSA slope.

Slope	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-15°	65.8	60.3	53.2	+75.1
16-30°	30.3	35.3	41.6	22.3
31-38°	3.9	4.4	5.2	2.6

Table 4. Percentages of availability and elk use related to CSA aspect.

Aspect	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
N	9.2	8.3	9.1	10.4
NE	20.5	16.1	16.9	21.2
E	9.7	8.4	6.5	6.7
SE	6.2	5.6	11.7	3.1
S	2.3	0.6	0.0	0.0
SW	15.2	20.4	19.5	16.6
W	16.3	17.3	14.3	14.5
NW	20.6	23.3	22.0	27.5

Table 5. Percentages of availability and elk use related to CSA topography.

Topography	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
Main stream	4.0	1.8	3.9	3.1
Lower slope	6.6	4.6	2.6	-2.1
Mid-slope	47.3	53.5	50.6	58.0
Secondary upper slope and ridgetop	12.7	16.6	23.4	8.8
Primary upper slope and ridgetop	16.1	11.2	7.8	9.8
Bench	5.0	5.6	3.9	5.2
Swale	4.6	4.8	7.8	7.8
Other	3.7	1.9	0.0	5.2

Table 6. Percentages of availability and elk use related to distance to water in the CSA.

Distance to water yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-50 (0-45)	18.3	17.9	16.9	23.3
50-150 (45-140)	23.9	28.1	33.7	21.2
150-250 (140-230)	21.2	22.6	18.2	23.9
250-350 (230-320)	15.3	16.4	22.1	12.4
350-450 (320-410)	11.6	10.4	7.8	11.9
450-850 (410-780)	9.7	--4.6	--1.3	7.3

Table 7. Percentages of availability and elk use related to CSA overstory canopy cover.

Overstory canopy cover	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-25%	5.0	7.2	++18.2	5.7
25-75%	45.0	47.8	44.2	-34.7
>75%	50.0	45.0	37.6	59.6

Table 8. Percentages of availability and elk use related to CSA sight distance.

Sight distance yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
<50 (<46)	33.1	31.8	35.1	26.9
50-100 (46-91)	58.3	58.7	--39.0	64.3
>100 (>91)	8.6	9.5	++25.9	8.8

Table 9. Percentages of availability and elk use related to CSA tree stand type.

Tree stand type	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
Dense PSME-LAOC	10.8	+16.5	+25.9	10.4
Moderate PSME-LACO	9.9	15.0	19.5	7.3
Scattered large PSME	3.2	4.6	13.0	4.7
Clearing	4.0	6.0	13.0	4.1
Dense ABLA-PIEN	14.8	13.9	7.8	12.9
Moderate ABLA-PIEN	5.6	5.6	3.9	7.3
Small to medium PICO	8.4	4.4	-0.0	8.3
Medium to large PICO	43.3	--34.0	--16.9	45.0

PSME - Pseudotsuga menziesii
ABLA - Abies lasiocarpa
PICO - Pinus contorta
LAOC - Larix occidentalis
PIEN - Picea engelmanni

Table 10. Percentages of availability and elk use related to CSA successional stage.

Successional stage	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
Brush-Seedling	1.8	1.1	3.9	1.6
Pole-Sapling	3.3	1.4	1.3	1.6
Young-Stand	43.5	--30.5	--16.9	52.8
Mature Stand	27.6	33.8	31.2	30.0
Old Stand	23.8	++33.2	++46.7	--14.0

Table 11. Percentages of availability and elk use related to CSA dominant understory species.

Dominant understory species	% Availability*	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
Festuca idahoensis-Agropyron spicatum	5.8	++11.4	++26.0	3.6
Calamagrostis rubescens	10.1	13.5	15.6	8.8
Arnica cordifolia	6.6	7.8	10.4	3.6
Xerophyllum tenax	35.1	35.6	31.2	35.8
Vaccinium scoparium	17.1	--7.8	--5.2	9.8
Vaccinium globulare	31.9	33.2	39.0	34.2
Menziesia ferruginea	23.1	24.0	--7.8	26.9
Alnus sinuata	27.7	24.4	--11.7	30.6
Arnica latifolia	11.4	11.9	-3.9	17.6
Senecio triangularis	5.2	5.7	-0.0	10.4
Calamagrostis canadensis	5.0	3.4	1.3	6.7
Other	16.6	17.4	++39.0	--7.8

*Since the two dominant species on each segment were recorded, the percentages total to more than 100 percent.

Response to disturbance. During fall 1979, work on the main haul road was completed (Fig. 9), and the east side spur road was extended from BN cut number 3 into BN cut number 5. Work stopped prior to the opening of the general hunting season, and all roads were closed to vehicular access.

Logging was started on BN cuts 1 through 5 during winter 1980, and continued through the general hunting season. Spur road construction on the west side of the CSA began in late July. The first three weeks of this period were primarily used for equipment preparation. Road construction began in earnest on 12 August. From this time until mid-September a three pronged spur road was constructed within subunit 2. This road accesses BLM unit 1 and BN unit 7. A second spur road was constructed between mid-September and late October. This road begin in subunit 2 and continued into subunit 3. This spur accesses BLM cutting unit 2 and BN cutting units 8 and 9. The third spur road constructed within the CSA during 1980 began in early November. This

Table 12. Percentages of availability and elk use related to CSA habitat types.

Habitat Type	% Availability	% Elk Use (OVO Pellet) Fall 1979	% Elk Use (FN Pellet) Spring 1980	% Elk Use (FN Pellet) Summer 1980
PSME/FEID	2.5	5.5	+15.6	0.5
PSME/CARU, AGSP	1.6	+4.5	7.8	1.6
PSME/CARU[1]	4.7	4.2	5.2	3.1
PSME/PHMA[2]	0.6	1.4	2.6	0.0
PSME/VAGL-XETE[3]	1.3	2.5	0.0	0.5
PSME/LIBO[4]	1.1	1.8	5.2	0.0
PSME/SYAL[5]	0.9	1.9	1.3	1.6
ABLA/LIBO	1.9	2.5	3.9	1.6
ABLA/LIBO-XETE	14.6	20.4	29.8	17.1
ABLA/XETE-VAGL[6]	26.0	--17.2	--6.5	19.6
ABLA/XETE-VASC	5.0	--1.2	2.6	3.1
ABLA/MEFE	24.8	24.8	--6.5	31.5
ABLA/ALSI	4.0	2.9	1.3	3.1
ABLA/CLUN[7]	1.3	1.9	3.9	2.6
ABLA/CACA-CACA	3.6	4.1	0.0	9.3
ABLA/CACA-GATR[8]	2.5	1.8	3.9	1.6
ABLA/CACA-VACA[9]	1.4	0.0	0.0	1.6
Clearcut	2.0	1.1	3.9	1.6
Rock	0.2	0.3	0.0	0.0

[1]Includes ABLA/CARU
[2]Includes PSME/PHMA-CARU
[3]Includes PSME/VAGL
[4]Includes PSME/LIBO-SYAL, PSME/LIBO-VAGL, and PSME/LIBO-CARU
[5]Includes PSME/SYAL-CARU and PSME/SYAL-AGSP
[6]Includes ABLA/VAGL
[7]Includes ABLA/CLUN-ARNU and ABLA/CLUN-MEFE
[8]Includes ABLA/GATR
[9]Includes ABLA/VACA and wet meadows

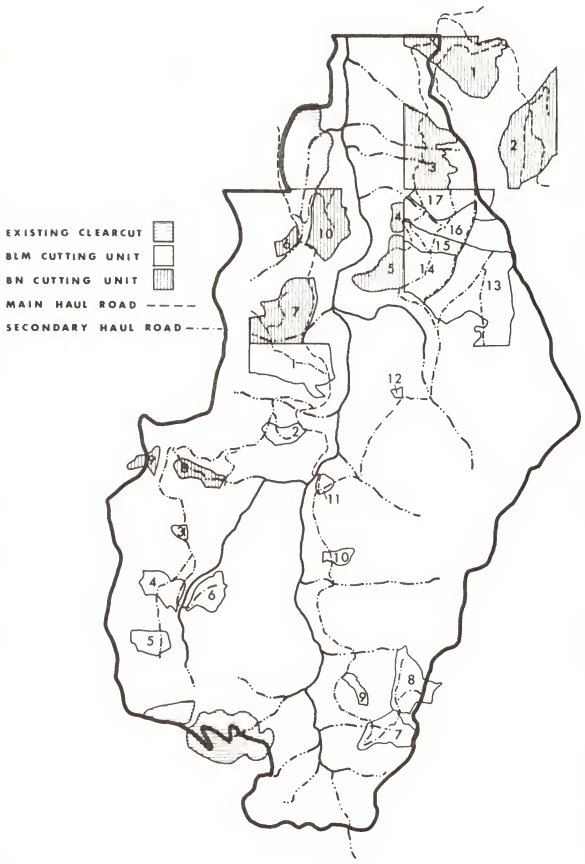

Figure 9. Map of existing clearcuts, planned cutting units, and planned roads in the CSA.

spur starts in subunit 1 just within the CSA boundary and accesses BN cutting unit 10. This spur was completed near the end of November. Construction of the east side spur roads, originating in BLM cutting unit 11, started in early December 1980.

The greatest amount of road building and logging activity in the CSA during this report period occurred in subunit 8 (Fig. 3). However, elk use in subunit 8 was significantly much greater than availability during fall 1979 and spring 1980 (Table 1). Use was approximately equal to availability in subunit 8 during summer 1980. Also, no significant avoidance of subunits 1 and 2 by elk during road construction was noted in fall 1979 and summer 1980. Relative elk use was low in these subunits (1 and 2) even before disturbance.

Elk use within 150 yards (140 m) of new CSA roads did not differ significantly from availability (Table 13). At the 150-550 yard (140-500 m) interval use was significantly greater than availability during fall 1979 and spring 1980. During summer 1980 use of areas greater than 1350 yards (1230 m) was significantly in excess of availability. During spring 1980, use of areas greater than 950 yards (870 m) was significantly less than availability. Tables 14 and 15 show elk use and availability values as related to distance to proposed roads and cutting units in the CSA. Elk selected for areas in or within 150 yards (140 m) of proposed cutting units during fall 1979, otherwise no distinct patterns of preference or avoidance were noted. Similarly, elk distribution with respect to existing clearcuts (and a seed tree cut) and old roads in the CSA showed some seasonal variation, but no significantly distinctive trends (Tables 16 and 17).

Future cutting units. Table 18 shows a summary of pellet groups per 1000 steps within proposed cutting units (Fig. 9) for fall 1979, and spring and summer 1980. BN cutting units were not delineated when the pellet transects were installed, so transects may extend beyond cut boundaries. Thus, results for those units are approximate. Also, four BN units were not sampled. Units 1 and 2 are outside the CSA, and units 4 and 9 are not crossed by a transect. Two other BN units (8 and 10) are only marginally sampled by our original transects, but a special transect was installed across unit 10. Results from the special transect are not included here.

As previously reported (Marcum et al. 1979 and 1980), elk use of proposed cutting units varies substantially, both seasonally and yearly. However, a number of proposed cutting units, especially those in the northeast and southwest portions of the CSA, tend to receive much greater elk use than the CSA as a whole. Also, elk use on all proposed cutting units was higher than use of areas which will not be logged, for all seasons considered.

Table 13. Percentages of availability and elk use related to distance to new roads constructed within the CSA since spring 1978.

Distance yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-150 (0-140)	9.2	6.4	11.7	5.2
150-550 (140-500)	22.4	++32.2	++54.5	21.2
550-950 (500-870)	14.0	13.9	22.1	8.8
950-1350 (870-1230)	11.3	9.7	--1.3	10.4
>1350 (>1230)	43.1	37.8	--10.4	+54.4

Table 14. Percentages of availability and elk use related to distance to proposed roads within the CSA.

Distance yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-150 (0-140)	28.9	31.1	31.2	25.9
150-550 (140-500)	45.4	49.4	57.0	47.2
550-950 (500-870)	18.2	15.7	-7.8	21.2
950-1350 (870-1230)	6.3	3.3	3.9	4.7
>1350 (>1230)	1.2	0.5	0.0	1.0

Table 15. Percentages of availability and elk use related to distance to proposed cutting units within the CSA.

Distance yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-150 (0-140)	34.1	++44.6	46.7	26.4
150-550 (140-500)	37.5	32.5	41.6	37.9
550-950 (500-870)	19.3	16.4	--7.8	27.5
950-1350 (870-1230)	7.5	5.3	2.6	4.1
>1350 (>1230)	1.6	1.2	1.3	4.1

Table 16. Percentages of availability and elk use related to distance to existing clearcuts.

Distance to existing clearcuts yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-150 (0-140)	6.1	4.5	6.5	4.2
150-550 (140-500)	11.6	12.3	9.1	8.8
550-950 (500-870)	15.5	18.0	28.6	15.5
950-1350 (870-1230)	15.5	18.3	27.2	16.1
>1350 (>1230)	51.3	46.9	--28.6	55.4

Table 13. Percentages of availability and elk use related to distance to new roads constructed within the CSA since spring 1978.

Distance yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-150 (0-140)	9.2	6.4	11.7	5.2
150-550 (140-500)	22.4	++32.2	++54.5	21.2
550-950 (500-870)	14.0	13.9	22.1	8.8
950-1350 (870-1230)	11.3	9.7	--1.3	10.4
>1350 (>1230)	43.1	37.8	--10.4	+54.4

Table 14. Percentages of availability and elk use related to distance to proposed roads within the CSA.

Distance yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-150 (0-140)	28.9	31.1	31.2	25.9
150-550 (140-500)	45.4	49.4	57.0	47.2
550-950 (500-870)	18.2	15.7	-7.8	21.2
950-1350 (870-1230)	6.3	3.3	3.9	4.7
>1350 (>1230)	1.2	0.5	0.0	1.0

Table 15. Percentages of availability and elk use related to distance to proposed cutting units within the CSA.

Distance yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-150 (0-140)	34.1	++44.6	46.7	26.4
150-550 (140-500)	37.5	32.5	41.6	37.9
550-950 (500-870)	19.3	16.4	--7.8	27.5
950-1350 (870-1230)	7.5	5.3	2.6	4.1
>1350 (>1230)	1.6	1.2	1.3	4.1

Table 16. Percentages of availability and elk use related to distance to existing clearcuts.

Distance to existing clearcuts yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-150 (0-140)	6.1	4.5	6.5	4.2
150-550 (140-500)	11.6	12.3	9.1	8.8
550-950 (500-870)	15.5	18.0	28.6	15.5
950-1350 (870-1230)	15.5	18.3	27.2	16.1
>1350 (>1230)	51.3	46.9	--28.6	55.4

Table 17. Percentages of availability and elk use related to old roads in the CSA, constructed prior to spring 1978.

Distance to road yards (meters)	% Availability	% Elk Use (OVO Pellets) Fall 1979	% Elk Use (FN Pellets) Spring 1980	% Elk Use (FN Pellets) Summer 1980
0-150 (0-140)	12.4	8.6	10.4	7.3
150-550 (140-500)	27.4	27.5	36.3	25.4
550-950 (500-870)	27.7	33.1	24.7	33.1
950-1350 (870-1230)	21.6	24.4	20.8	24.9
>1350 (>1230)	10.9	-6.4	7.8	9.3

Table 18. Pellet groups per 1,000 steps in proposed CSA cutting units.

Cutting unit	Pellet Groups per 1,000 Steps (OVO Pellets) Fall 1979	(FN Pellets) Spring 1980	(FN Pellets) Summer 1980
BLM			
1	2.3	0.0	0.0
2	0.0	0.0	3.1
3	13.7	0.0	0.0
4	14.7	0.8	3.3
5	27.5	0.0	5.5
6	17.3	0.0	9.6
7	6.7	0.0	3.3
8	8.6	0.0	1.4
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	14.2	0.0	9.4
13	11.5	0.0	3.4
14	22.0	1.0	5.0
15	16.2	0.0	0.0
16	12.8	0.0	0.0
17	26.2	0.0	2.4
BN			
3	27.7	5.4	2.7
5	4.3	4.3	1.1
6	6.4	0.0	1.6
7	10.4	0.0	4.0
8	10.2	0.0	0.0
10	11.0	0.0	4.4
CORE STUDY AREA	8.7	0.9	2.4
ALL CUTS	13.4	1.1	2.9
NON CUT	7.8	0.9	2.3

Elk use in the CSA related to precipitation. Figure 10 shows cummulative precipitation from October through the following September for 1979-80, as compared to that for a 20 year mean and several previous years. Precipitation data are from the Lubrecht Experimental Forest of the University of Montana School of Forestry, located approximately 7 miles west of the CSA (Steele 1980). During 1979-80, precipitation was less than normal through April, but record rainfall during May resulted in higher than normal cumulative moisture for the year.

As reported previously (Marcum et al. 1979 and 1980), we have shown a significant inverse relationship between precipitation and summer elk use of the CSA during years of little or no disturbance. After adding the precipitation and pellet count data for 1980, we still show a high correlation. The best result ($r = -0.98$) is obtained by using data from even numbered transects only (Fig. 11), for which we now have 6 years of data. The correlation between precipitation and summer pellet counts on all transects from 1976 through 1980 remained at $r = -0.95$. A similar correlation ($r = -0.99$) has been shown for October through May or June precipitation with the spring pellet counts for 1977 through 1979. The spring 1980 pellet count data were revised, so the total count was not used in linear regression tests.

Telemetry Results

For the purpose of this report the 1980 field season runs from 13 May to 1 December, 1980, although weekly flights have continued since this period. A total of 29 flights resulted in 438 aerial locations of 19 radio-collared female elk during 1980. Visual observations accounted for 202 (46.1%) of these locations. No locations were made on bull elk. All aerial locations were used for analyses of habitat utilization and disturbance relationships. Three aerial locations that fell far outside the study were not used in calculating home range and movement statistics.

Distribution and movements. During the winter of 1979-80, 24 elk were trapped, and eight adult elk were radio-collared. One radioed animal was a bull trapped at the Grace's Landing trap, the remaining seven were cows. Of these seven cows, five were trapped at Grace's Landing, the other two were captured at the Lindbergh trap. A total of 22 radio-collared animals were thought to have been in the study area at the beginning of the 1980 field season. Radio locations were never obtained for three of these animals. Two of these animals were trapped at the Scotty Brown trap in 1977 and were located inconsistently during the 1979 field season. The remaining animal was the bull trapped in 1980. It was thought to have left the study area after the first several flights failed to locate him. However, he was shot in the study area during the hunting season, the radio-collar having malfunctioned. At the end of the hunting season 10 radio-collared animals with functional transmitters remained in the study area. Hunter kills accounted for five (55.6%) of the nine animals lost during the 1980 field season. Of

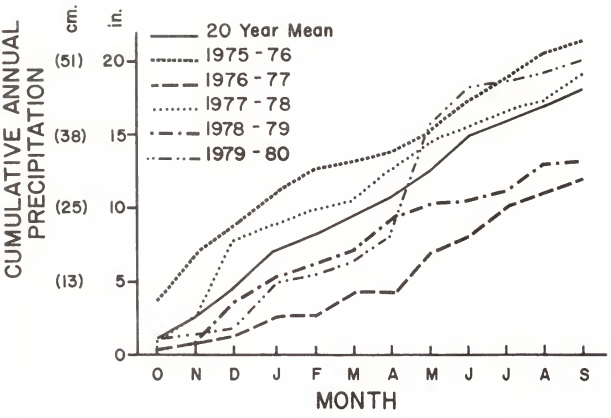

Figure 10. Cumulative annual precipitation at Lubrecht Experimental Forest (Steele 1981).

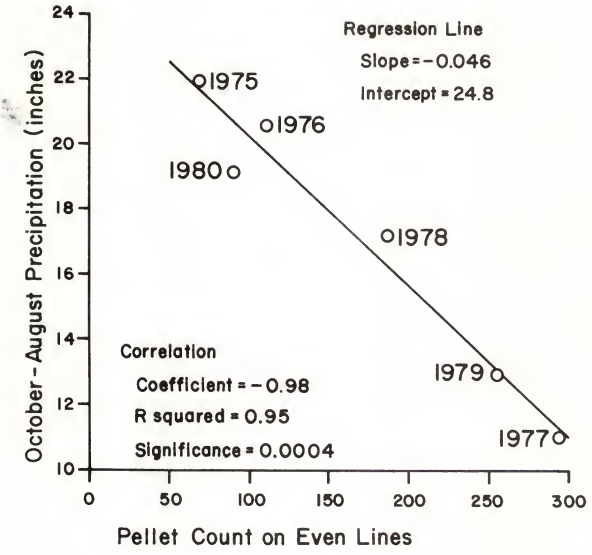

Figure 11. Linear regression of yearly summer pellet counts in the CSA against annual precipitation.

the remaining four, one radio-collar broke off in early December, and the other three stopped transmitting. Home range polygons and seasonal and total geographic centers of activity for each radioed animal are shown in Figures 12 through 21.

Total use of the CSA, which comprises 15% of the total study area, for all radio-collared animals was proportional to availability. On a seasonal basis, use of the CSA was significantly greater than availability only during the hunting season (++36.4%). Use during the remaining seasons was approximately equal to availability: calving (8.1%), summer (13.5%), and rut (20.4%). Different patterns of use with respect to the CSA were evident by trapsite. Total and seasonal use of the CSA was not significantly different than availability for animals captured in the Lindbergh-Potter traps. Use of the CSA by the Grace's Landing animals was significantly greater than availability for the hunting season (++54.9%) and for the total season (+24.1%). The majority of the locations for the Grace's Landing animals were north of the CSA (65.8%). Lindbergh-Potter animals were west of the CSA for 70.8% of their locations. Overlap in use of the study area by these two groups was small (Fig. 22).

Statistics on distribution and movements for all radio-collared elk are presented in Table 19. The total area used by all animals was approximately 72 miles^2 (188 km^2) from May to December. Total home range for the two groups was approximately equal. Composite home range area was approximately 37.9 miles^2 (98.5 km^2) for the Grace's Landing animals and 37.8 miles^2 (99.3 km^2) for the Lindbergh-Potter animals. May to December home ranges for individual elk tracked all seasons ranged from 6.8 miles^2 (17.7 km^2) to 23.0 miles^2 (59.9 km^2) with an average of 13.0 miles^2 (33.8 km^2). Home ranges of Grace's animals for this period averaged 10.4 miles^2 (27.0 km^2). Lindbergh-Potter animals had a larger mean home range area of 15.6 miles^2 (40.6 km^2). Seasonal home range areas for all animals were smallest during the calving season - 1.3 miles^2 (3.4 km^2). No significant difference was noted in mean home range area for the remaining season: summer (4.6 miles^2; 12.0 km^2), rut (4.7 miles^2; 12.2 km^2) and hunt (4.4 miles^2; 11.4 km^2).

Mean distance moved between successive locations followed a pattern similar to that for home range areas. Calving season showed the smallest grand mean of 1.2 miles (1.9 km) as well as the smallest mean movement for individual elk (0.5 miles; 0.8 km). The other grand mean values were 1.9 miles (2.7 km) for the summer and total seasons and 2.0 miles (3.2 km) for the rut and hunt. Grand means were smaller for the Grace's Landing versus Lindbergh-Potter groups during calving (1.0 miles; 2.6 km versus 1.6 miles, 4.2 km), summer (1.5 miles; 3.9 km versus 2.2 miles; 5.7 km), hunt (1.6 miles; 4.2 km versus 2.6 miles; 6.8 km) and total (1.5 miles; 3.9 km versus 2.1 miles; 5.5 km).

Maximum distance moved between successive locations followed the same pattern as mean distance for the two groups of animals. The

LEGEND FOR

FIGURES 12-21

Home Range Polygons

15 May - 1 December 1980

Activity Centers

C = Calving, 15 May-15 June
S = Summer, 16 June-31 August
R = Rutting, 1 September-20 October
H = Hunting, 21 October-1 December
T = Total, 15 May May-1 December

Grace's Landing Trap--Elk 11, 12, 22, 25, 32, 341, 35, 37, 38, 46

Lindbergh Trap--Elk 13, 14, 211, 280, 33, 312

Potter Trap--Elk 31, 340, and 39

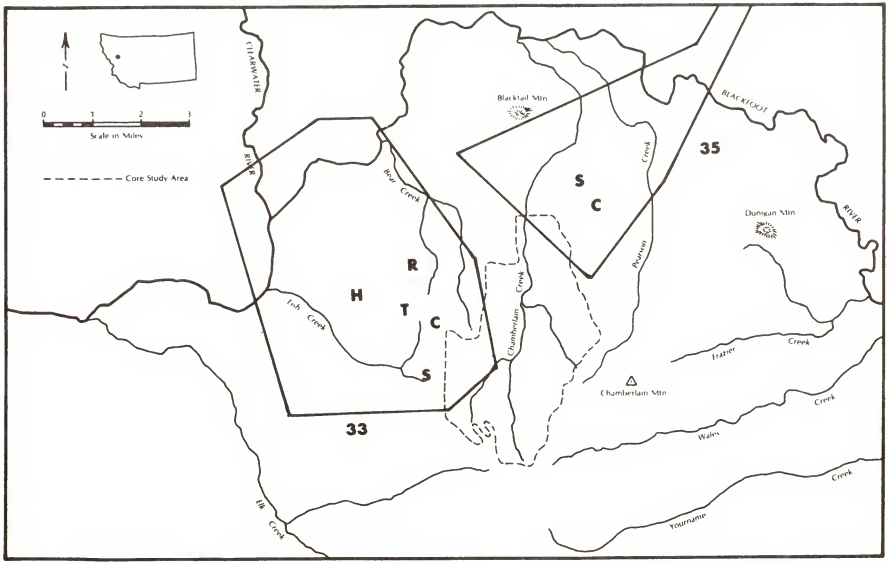

Figure 12. Home range polygons and activity centers for female elk 33 and 35.

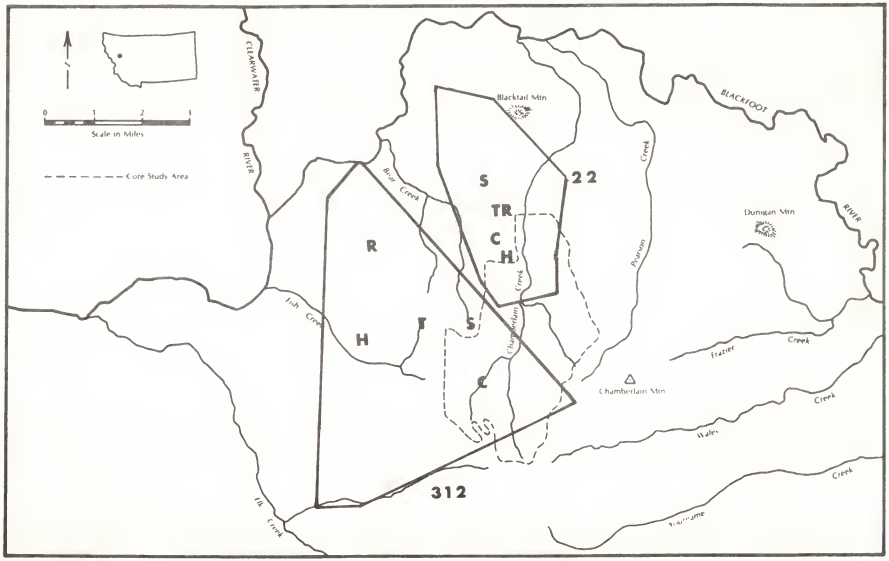

Figure 13. Home range polygons and activity centers for female elk 312 and 22.

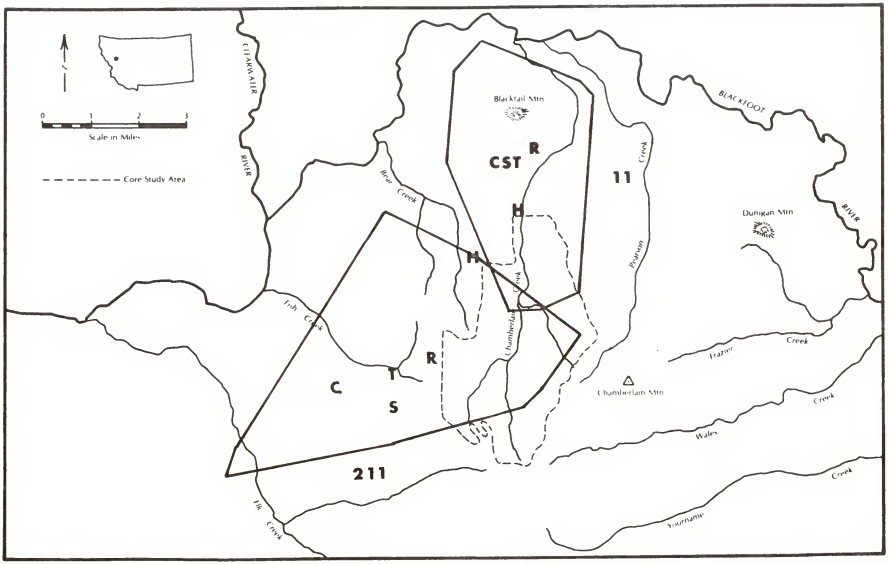

Figure 14. Home range polygons and activity centers for female elk 211 and 11.

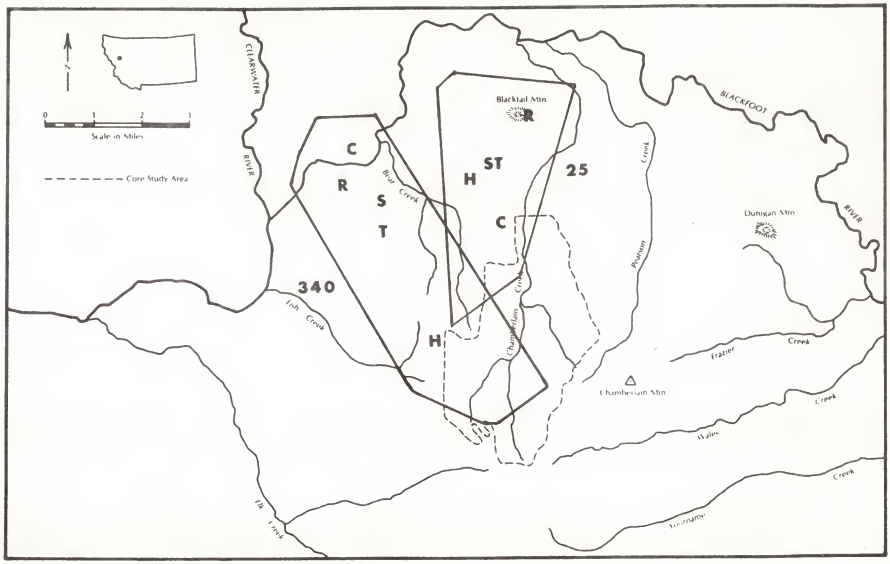

Figure 15. Home range polygons and activity centers for female elk 340 and 25.

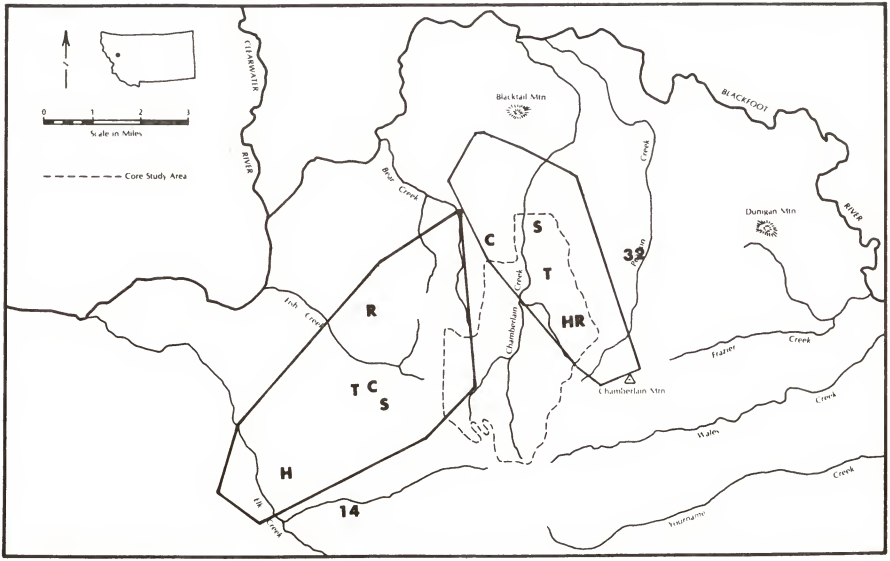

Figure 16. Home range polygons and activity centers for female elk 14 and 32.

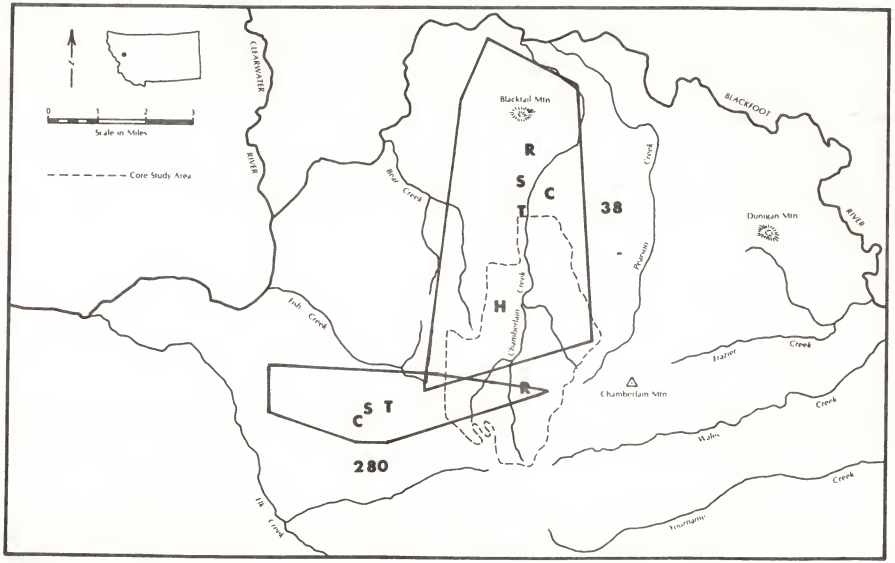

Figure 17. Home range polygons and activity centers for female elk 280 and 38.

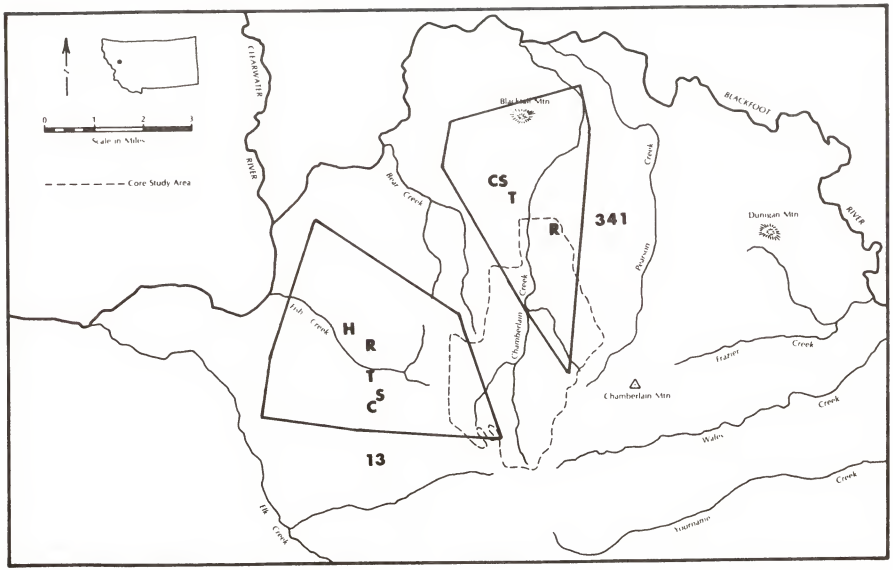

Figure 18. Home range polygons and activity centers for female elk 13 and 341.

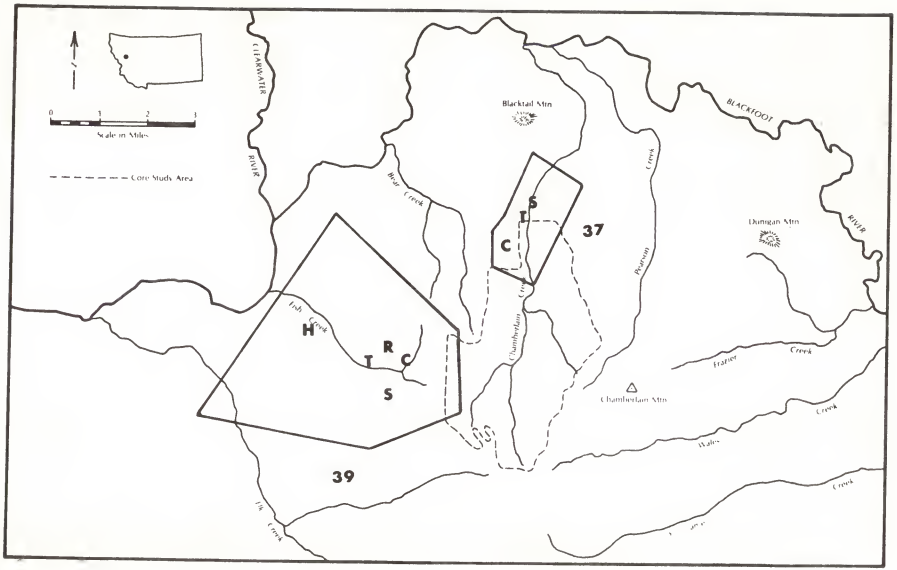

Figure 19. Home range polygons and activity centers for female elk 39 and 37.

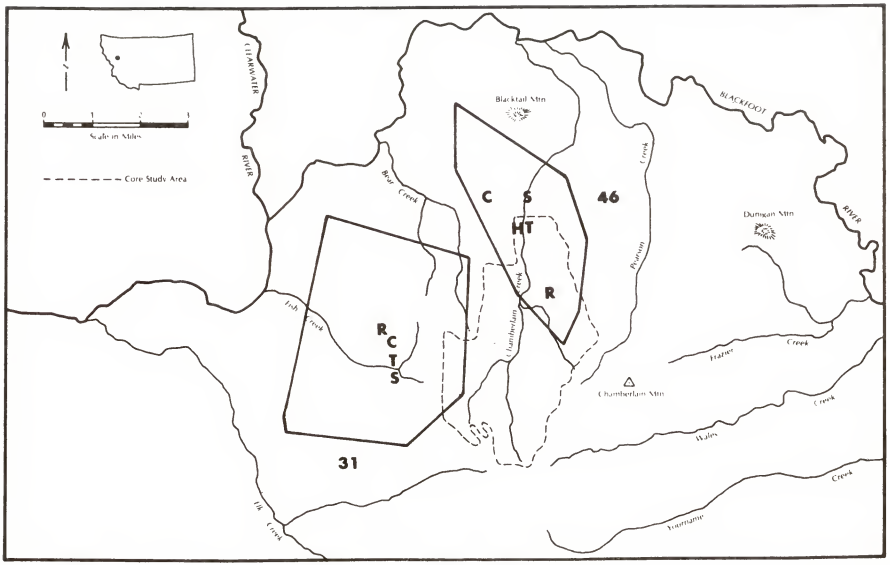

Figure 20. Home range polygons and activity centers for female elk 31 and 46.

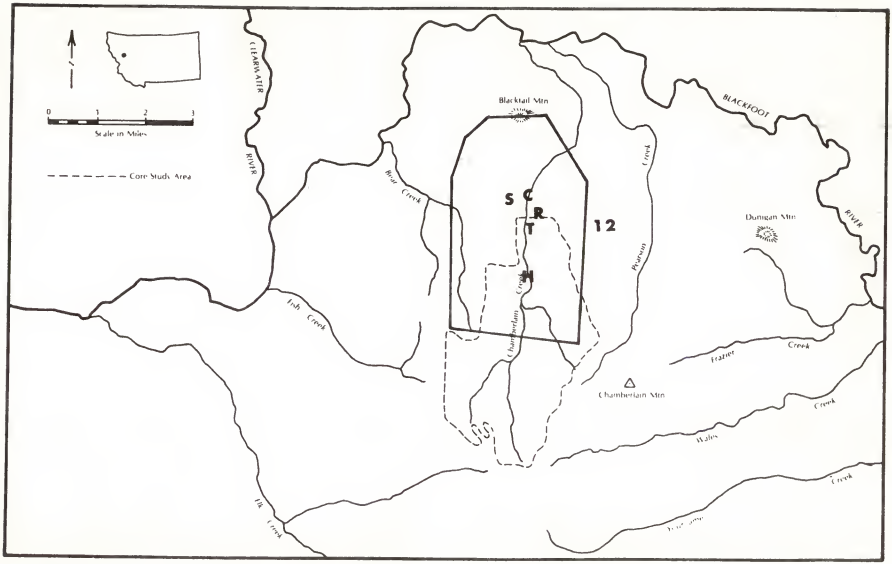

Figure 21. Home range polygon and activity centers for female elk 12.

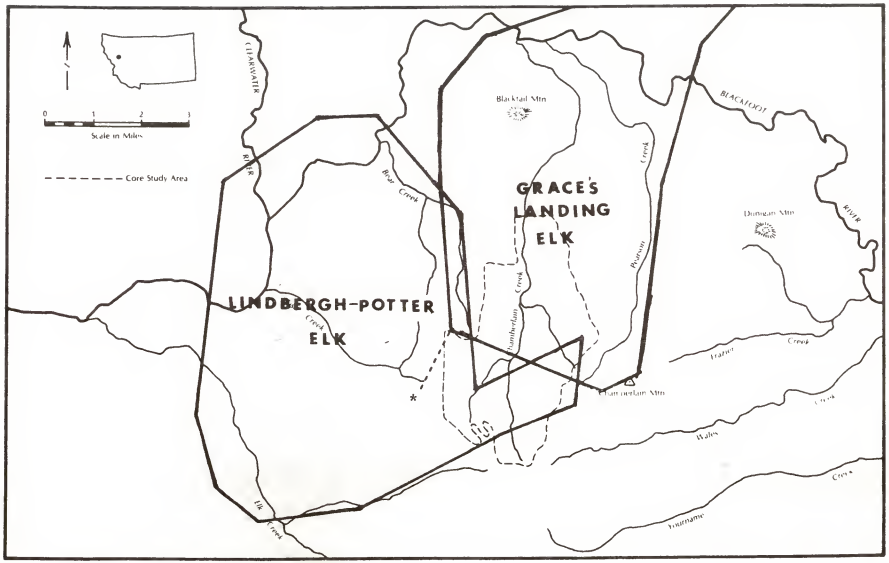

Figure 22. Primary areas used during 1980 by female radio-equipped elk, grouped by trapsite.
* Represents one location for one animal far outside its normal range during hunting season.

Table 19. Distribution and movement statistics for 19 radio-tagged elk tracked from 15 May - 1 December 1980.

Female elk #	Age[1]	Trap site*	Location and distances (aerial miles), Seasonal and total relocations: Calving May 15 - June 15 — No[2]	x̄[3]	Area[4]	Max[5]	Sten. dia[6]	Summer June 16 - July 31 — No	x̄	Area	Max	Sten. dia	Rut Sept 1 - Oct 20 — No	x̄	Area	Max	Sten. dia	Hunting Season Oct 21 - Nov 30[7] — No	x̄	Area	Max	Sten. dia	Total May 15 - Dec 1 — No	x̄	Area	Max	Sten. dia	Maximum distance between any 2 locations
11	4½	GL	4	0.5	0.14	0.9	0.7	9	1.1	2.45	2.2	2.0	7	3.2	6.33	5.6	4.1	7	1.4	4.87	4.4	4.6	27	1.5	12.78	5.6	3.5	5.8
12	3½	GL	4	0.8	0.33	1.1	1.7	9	1.4	4.77	4.6	3.0	7	1.7	6.02	4.4	3.6	7	1.0	1.39	1.5	1.8	27	1.4	11.46	4.6	3.2	5.1
22	3½	GL	5	1.2	0.77	1.8	1.6	8	1.8	4.82	3.2	2.6	5	1.9	3.25	4.0	3.0	6	2.0	3.14	4.0	2.9	24	1.7	8.26	4.0	3.0	5.0
23	5½	GL	5	1.1	1.43	1.4	2.1	8	1.3	3.41	2.2	2.3	7	1.1	0.68	2.3	1.6	7	1.6	3.95	4.1	4.3	27	1.2	9.96	4.1	3.3	5.6
32	4½	GL	4	0.7	0.17	1.0	1.0	9	1.8	8.12	5.8	4.0	7	1.6	2.91	6.1	4.0	6	0.5	0.40	1.1	1.4	26	1.4	≤2.67	6.1	≤4.1	6.1
341[8]	3½	GL	4	1.4	1.37	1.8	2.3	9	1.4	5.82	4.0	2.7	5	4.3	5.34	6.2	5.1	0	-	-	-	-	18	2.2	10.60	6.2	3.7	6.2
35[9]	4½	GL	4	1.3	1.10	1.7	1.9	6	1.3	1.49	2.5	2.5	7	1.4	0.95	2.4	1.8	4	2.3	2.08	4.7	3.6	21	1.6	14.44	4.7	4.6	6.8
37[10]	3½	GL	4	0.9	0.38	0.9	1.1	4	1.2	1.09	1.9	1.8	0	-	-	-	-	0	-	-	-	-	8	1.1	2.32	1.9	1.9	2.5
38	6½	GL	4	1.5	1.37	2.0	1.8	8	1.6	4.03	2.9	2.6	6	3.1	7.41	4.7	4.1	7	1.9	9.54	4.3	4.4	25	2.0	18.08	4.7	4.4	7.4
44[11]	3½	GL	3	0.5	0.03	0.6	0.5	9	1.8	4.83	5.1	2.9	6	1.3	2.83	2.3	2.4	5	2.3	1.88	4.0	3.6	23	1.5	6.85	5.1	3.2	5.4
13[12]	6½	L	4	1.7	1.78	2.8	2.8	10	2.7	5.42	4.6	3.2	7	2.3	8.88	4.0	3.9	2	4.3	-	4.3	4.3	23	2.5	13.11	4.6	3.7	5.8
14	3½	L	4	2.4	0.61	4.4	3.6	10	1.9	3.57	3.9	2.7	7	2.6	4.86	6.2	4.3	7	1.6	3.20	2.7	3.1	28	2.1	16.85	6.2	4.5	7.6
211[13]	5½	L	4	1.7	1.07	2.7	3.5	10	2.3	9.04	4.5	4.6	7	1.9	10.51	4.0	4.5	1	-	-	-	-	22	2.0	20.37	4.5	4.8	7.6
280[14]	2½	L	3	1.0	0.08	1.5	1.2	9	2.4	3.98	3.3	3.0	2	0.9	-	0.9	0.9	0	-	-	-	-	14	1.8	5.54	3.3	3.5	5.7
33	3½	L	4	1.7	0.76	3.4	2.9	8	2.3	5.70	3.6	3.1	7	2.9	4.76	6.3	4.5	7	2.2	5.66	4.4	4.7	26	2.5	23.03	8.3	4.5	6.6
312	3½	L	4	1.8	3.66	2.8	3.6	10	2.5	5.92	5.5	4.4	7	1.4	2.51	2.2	2.1	7	1.9	7.02	5.7	6.0	28	1.9	19.53	5.7	5.3	7.0
31[15]	5½	F	4	1.6	1.52	2.1	2.1	10	2.5	6.33	3.9	3.2	5	2.9	7.82	4.0	4.0	0	-	-	-	-	19	2.2	12.67	4.0	3.3	5.2
340	5½	F	2	1.5	-	1.5	1.5	9	2.2	3.24	4.4	3.5	7	1.7	2.29	3.0	2.4	7	2.4	5.46	5.6	4.4	25	2.1	14.85	6.2	4.9	7.2
39[16]	5½	F	4	1.0	0.49	2.1	1.9	7	1.4	3.54	2.6	2.6	7	1.2	2.95	2.3	2.4	6	3.1	7.97	4.8	4.5	24	1.7	14.33	4.8	3.5	5.5
Cases			74					162					113					86					435					
Average				1.23	1.27	1.92	1.99		1.69	4.61	3.72	2.98		2.03	4.72	3.94	3.26		2.04	4.35	3.97	3.77		1.71	13.04	4.87	3.84	6.00
Std. Dev.				0.56	1.81	0.96	0.94		0.61	2.01	1.15	0.73		0.95	2.80	1.67	1.20		0.91	2.72	1.34	1.45		0.54	5.23	1.15	0.83	1.21

[1] Age at capture

[2] Number of relocations

[3] Average distance moved in miles between successive locations (1 mi = 1.6 km)

[4] Area in square miles based on connecting perimeter locations to form a polygon (1 mi^2 = 2.6 km^2)

[5] Maximum distance moved between successive locations

[6] Standard diameter in miles

[7] Includes 11 locations taken on December 1, 1980

[8] Killed during hunt October 19, 1980

[9] Killed during hunt November 18, 1980

[10] Last located July 22, 1980

[11] Killed during hunt November 26, 1980

[12] Killed during hunt October 26, 1980

[13] Killed during hunt October 26, 1980

[14] Last located September 12, 1980

[15] Last located October 18, 1980

[16] Collar broke off December 1, 1980

* GL = Grace's Landing, L = Lindberghs, F = Potters

largest difference occurred during the hunting season where the mean maximum was 3.5 miles (5.6 km) for the Grace's Landing group as compared to 4.6 miles (7.4 km) for the Lindbergh-Potter group. For the two groups combined, the individual maximums ranged from 0.6 miles (1.0 km) during the calving season to 6.3 miles (10.0 km) during the rut with a total mean value of 4.9 miles (7.8 km). Seasonally, the mean values for all animals was again lowest for the calving season (1.9 miles; 3.0 km). The summer (3.7 miles; 5.9 km), rut (3.9 miles; 6.2 km) and hunt (3.9 miles; 6.2 km) values were similar in magnitude.

Standard diameters (Lonner 1976, after Harrison 1958) again demonstrate the disparity between the two groups of animals with respect to movements. The largest disparity was during the hunting season with a mean standard diameter of 4.5 miles (7.2 km) for the Lindbergh-Potter group as compared to 3.3 miles (5.3 km) for the Grace's Landing group. The differences in mean standard diameter between the two groups ranged from no difference during the rut to 1.1 miles (1.8 km) during the calving season. In addition to generally larger standard diameters, the variation in these values for the Lindbergh-Potter animals was greater than those for the Grace's Landing animals for all seasons except the rut. Standard diameters for all animals ranged from 0.5 miles (0.8 km) during the calving season to 6.0 miles (9.6 km) during the hunting season, with a grand mean of 3.8 miles (6.1 km). The mean seasonal standard diameters for all animals increased throughout the field season from 2.0 miles (3.2) for the calving season to 3.8 miles (6.1 km) for the hunting season.

Total and seasonal geographic centers of activity again demonstrate the relatively low use of the CSA during 1980 as well as the difference in use by the two groups. Of 68 seasonal centers of activity, 10 fell within the CSA, eight of these were for Grace's Landing animals. All three of the total centers of activity that fell within the CSA were for Grace's Landing animals.

Topographic factors. The study area ranges in elevation from 3800 to 6800 feet (1160-2070 m). Within this elevation range, the majority of elk locations were between 4500-5600 feet (1370-1700 m) (Table 20). Elevations between 3800 and 4400 feet (1160-1340 m) were used significantly less than availability during the calving, summer, and hunting seasons as well as for all seasons combined. In the next elevation interval (4500-5000 feet; 1370-1520 m), use was proportional to availability throughout all seasons except summer, in which use significantly exceeded availability. Within the 5100-5600 feet (1550-1700 m) interval, use significantly exceeded availability during the calving and hunting seasons and for all seasons combined. Elevations between 5700 feet (1740 m) and 6800 feet (2070 m) were used according to availability during each season and for all seasons combined.

Table 20. Percentages of availability and elk use related to study area elevation, 1980.

Elevation feet (meters)	% Availability N 400	% Elk Use Calving 74	Summer 163	Rut 113	Hunt 88	Total 438
3800-4400 (1160-1340)	40.8	--14.9	--16.0	29.2	--18.2	--19.6
4500-5000 (1370-1520)	25.0	40.3	++42.9	22.1	19.3	32.4
5100-5600 (1550-1700)	14.5	++36.5	22.1	21.2	++42.0	++28.3
5700-6200 (1740-1890)	15.0	6.8	14.7	19.5	15.9	14.8
6300-6800 (1920-2070)	4.8	1.4	4.3	8.0	4.5	4.8

Slopes within the study area are primarily less than 16°. The majority of elk locations were on these gentle (0-15°) slopes (Table 21), with use being significantly greater than availability during the summer season and for all seasons combined. On slopes of moderate steepness (16-30°), use was proportional to availability except during the summer season and for all seasons combined in which use was significantly less than availability. Steep slopes (>30°) were used less than availability for the calving and summer seasons, but conformed to availability for the remainder of the year.

Table 21. Percentages of availability and elk use related to study area slope, 1980.

Slope	% Availability N 400	% Elk Use Calving 74	Summer 162	Rut 113	Hunt 88	Total 437
0-15°	59.0	68.9	++75.3	69.0	68.2	++71.2
16-30°	34.0	29.7	-23.5	25.7	25.0	-25.4
>30°	7.0	-1.4	--1.2	5.3	6.8	3.4

Aspects within the study area were in general used according to availability (Table 22). However, for all seasons combined, east aspects were used significantly more than what was available. Use on level sites was significantly less than availability for each season and for all seasons combined.

Table 23 presents elk locations in respect to slope position. Ridge tops, upper slopes and mid-slopes were used according to availability, although a majority of the locations were within these categories. Use on lower slopes was significantly less than availability throughout all seasons. Drainage bottoms were also used significantly less than availability throughout the 1980 field season, with the exception of the rutting season. Drainage heads were consistently used far in excess of availability.

Table 22. Percentages of availability and elk use related to study area aspect, 1980.

Aspect	% Availability N 400	% Elk Use Calving 74	Summer 163	Rut 113	Hunt 88	Total 438
N	16.8	10.8	11.0	13.3	13.6	12.1
NE	9.5	17.6	10.4	16.8	11.4	13.5
E	7.5	10.8	15.3	16.8	14.8	++14.8
SE	4.8	9.5	6.1	3.5	4.5	5.7
S	2.8	4.1	6.1	3.5	3.4	4.6
SW	9.8	5.4	9.8	5.3	6.8	7.3
W	13.5	16.2	21.5	9.7	13.6	16.0
NW	15.8	20.3	14.7	23.9	27.3	20.5
Level	19.8	--5.4	--4.9	--7.1	--4.5	--5.5

Table 23. Percentages of availability and elk use related to study area slope position, 1980.

Slope position	N	% Availability 400	% Elk Use Calving 74	Summer 163	Rut 113	Hunt 87	Total 437
Ridge top		8.8	8.1	12.9	11.5	12.6	11.7
Upper slope		25.0	35.1	20.8	33.6	23.0	27.0
Mid-slope		21.8	28.4	25.1	15.0	26.4	23.3
Lower slope		31.3	--9.1	--15.9	--13.3	-17.2	--14.4
Drainage bottom		8.8	--1.4	--0.6	5.3	--0.0	--1.8
Drainage head		4.5	+17.6	++24.5	++21.1	++20.7	++21.7

Horizontal configuration (Table 24) along the slope had little effect on elk use of the study area. Use of convex, concave and undulating configurations conformed to availability throughout all seasons and for all seasons combined. Straight slopes were used less than availability during the summer and hunting seasons as well as for all seasons combined.

Distance to water within the study area had little affect upon the distribution of elk (Table 25). The majority of locations fell within 50 (45 m) to 350 yards (320 m) of water. Areas closest to water (0-50 yards; 0-45 m) received significantly less use than availability during the calving and summer seasons and for all seasons combined. The interval from 150 to 250 yards (140-230 m) also received significantly less use during the calving season. The only other significant variation from availability occurred for all seasons combined in the interval greater than 550 yards (500 m) from water. These areas experienced more use than availability.

Table 24. Percentages of availability and elk use related to horizontal configuration along the slope contour, 1980.

Horizontal configuration	% Availability N 400	% Elk Use Calving 74	Summer 163	Rut 113	Hunt 88	Total 438
Convex	30.5	32.4	37.4	31.9	30.7	33.8
Straight	35.0	39.2	-23.3	28.3	-20.5	-26.7
Concave	26.0	24.3	28.8	33.6	39.8	31.5
Undulating	8.5	4.1	10.4	6.2	9.1	8.0

Table 25. Percentages of availability and elk use related to distance to water, 1980.

Distance to water yards (meters)	% Availability N 400	% Elk Use Calving 73	Summer 163	Rut 113	Hunt 88	Total 437
0-50 (0-45)	16.0	--2.7	--4.9	8.8	8.0	--6.2
50-150 (45-140)	23.0	30.1	19.0	13.3	17.0	19.0
150-250 (140-230)	24.0	-17.8	35.0	25.7	23.9	27.5
250-350 (230-320)	15.5	32.9	13.5	20.4	14.8	18.8
350-450 (320-410)	12.5	6.8	15.3	19.5	17.0	15.3
450-550 (410-500)	5.3	2.7	4.9	2.7	9.1	4.8
>550 (>500)	3.8	6.8	7.4	9.7	10.2	+8.5

Vegetative factors. Use of the study area related to percent overstory canopy coverage varied depending upon the season (Table 26). Use was proportional to availability for all classes during the calving season and for all seasons combined. During the summer season significantly less use was made of open sites and of sites in the 75-95% class, but use significantly exceeded availability for non-open sites with less than 25% canopy coverage. Significantly greater use of the 75-95% cover class occurred for both the rut and hunting seasons. The moderate class (25-75%) was used significantly less than availability during the hunt. Given the relatively low incidence of western larch (Larix occidentalis) within most of the study area, it is assumed that any site containing 75% or greater cover provides adequate thermal cover. Therefore, thermal cover-forage ratios are easily obtained by combining the last two cover classes into the percent thermal cover. Since a measure of hiding cover for the study area is not available, these ratios cannot be directly related to those discussed by Thomas et al. (1979). Available hiding cover for the study area will be evaluated next field season. The study area on the whole has thermal cover-forage ratio of 40:60. During 1980, elk used less thermal cover than that available during the calving (31:69) and summer (34:66) seasons. However, during the rut (61:39) and hunt (60:40) these ratios are significantly different ($p<0.01$), with more thermal cover being selected for. The use of thermal cover and forage in the study area over all seasons (46:54) is proportional to availability.

Table 26. Percentages of availability and elk use related to study area overstory canopy coverage, 1980.

Overstory canopy cover	N	% Availability 300	% Elk Use: Calving 74	Summer 163	Rut 113	Hunt 88	Total 438
OPEN		8.8	10.8	-3.1	6.2	3.4	5.3
<25%		13.8	17.6	++28.8	6.2	13.6	18.0
25-75%		37.4	40.5	34.4	26.5	-22.7	31.1
75-95%		31.0	27.0	-19.0	++54.0	++53.4	36.3
95-100%		9.1	4.1	14.7	7.1	6.8	9.4

Table 27 gives percentages of availability and elk use of the study area categorized by stand composition, age and canopy coverage. The pole-young, mixed category and the mature-old, mixed category were not differentiated for the 1980 data. Therefore, for the purpose of this analysis, these categories are combined. The majority of elk locations for all seasons occur in the mixed species cover types. Use was significantly greater than availability for the light to moderate mixed

species stands during the summer season and significantly less than availability during the hunting season. The densely stocked mixed species stands were used significantly more than availability during the rut and hunting seasons. All lodgepole stands were consistently used less than availability, but not significantly so. Use of the brush-seedling-sapling habitats varied with season. These areas received no use during the summer and rutting seasons. Use was greater than availability during the calving and hunting season (significantly so during the hunting season). The pasture-hayfield habitat was used significantly less than availability during each season and for all seasons combined. In general, use in other habitats approximated availability for all seasons.

Elk use by habitat type (Pfister et al. 1977) is shown in Table 28. Use of individual habitat types varied from season to season, but the majority of the habitat types were not used significantly different from their availability within the study area. Pasture-hayfields were used significantly less than availability during all seasons. The PSME/bunchgrass types were used less than availability for all seasons (significantly less during the summer and rut) except during the hunt. PSME/VACA was consistently used less than availability for all seasons, with siginificant differences occurring for the calving season and for all seasons combined. The PSME/SYAL and ABLA/CACA habitat types were consistently used less than availability. Use of the PSME/PHMA, PSME/VAGL, PSME/LIBO, PSME/CARU, ABLA/LIBO, and ABLA/XETE-VASC habitat types was generally greater than availability. Significantly greater use occurred during the summer and for all seasons combined within the PSME/CARU habitat type. Use significantly exceeded availability during the hunt and over all seasons for ABLA/LIBO and during the summer, hunt and all seasons combined within the ABLA/XETE-VASC habitat type. Use was significantly less than availability for ABLA/MEFE during the summer and for ABLA/XETE-VAGL during the hunting season.

Disturbance relationships. Distance to the nearest site of active human disturbance was recorded for each elk location. Whenever possible, distances were measured from elk locations to specific sites of human activity, such as logging and road construction, as observed while tracking elk from the air. Otherwise, general areas of disturbance for discrete time periods were used. Logging occurred from mid-winter through hunting season in five units on the east ridge of the Chamberlain Creek drainage. Three of these units were BN logging contracts within the CSA. Much of the lower south and southeast aspects of Blacktail Mountain above main Chamberlain Creek was selectively logged from early June to mid-October. Between mid-May and mid-July, Champion selectively logged several hundred acres on the south and west aspects of Bata Mountain. In addition to these units, Champion selectively logged a unit above Bear Creek Flats from mid-July until just prior to the hunting closure. Several small units were logged in Pearson Creek, east of the study area from mid-February to early May. In addition to these logging activities, numerous small tracts were thinned on E Bar L Ranch land from Fish Creek north to the Blackfoot River

Table 27. Percentages of availability and elk use related to habitat age, species composition and canopy coverage, 1980.

Age, species, canopy cover*	% Availability N 300	% Elk Use Calving 74	Summer 163	Rut 111	Hunt 87	Total 435
Pole-mature, mixed, light-mod.	43.0	50.0	+58.3	31.5	-26.3	43.7
Pole-mature, mixed, dense	26.4	25.7	20.9	++55.0	++47.1	35.6
Pole-young, LPP, light-mod.	1.3	0.0	0.0	0.0	0.0	0.0
Pole-young, LPP, dense	13.0	5.4	12.3	5.4	6.9	8.3
Brush-seedling-sapling	1.3	5.4	0.0	0.0	++14.9	3.9
Dry meadow	1.3	1.4	1.2	2.7	1.1	1.6
Wet meadow	0.7	0.0	0.6	0.0	1.1	0.5
Pasture-hayfield	6.3	--0.0	--0.0	-0.9	--0.0	--0.2
North slope clearcut	2.7	9.5	1.2	0.9	1.1	2.5
Road	2.0	1.4	3.1	0.9	0.0	1.6
Other**	2.0	1.4	2.5	2.7	1.1	2.1

*Canopy cover: light <25%; moderate 25-75%; dense >75%

**Other: brushy riparian, water, scree, rock

throughout the 1980 field season. In addition to the road construction within the CSA (mentioned in the pellet count results section) another spur road was constructed within the greater study area. During the first two weeks of October, Champion constructed a road towards the Fish Creek drainage. This spur connects with the Sunset Hill road just north of Elk Creek.

Table 29 gives the distribution of elk locations in respect to non-road disturbances. Analysis from previous years did not include the hunting season because all activities stopped during that period. Although this years analysis does include the hunting season it was not possible to spearate hunter pressure from other forms of disturbance. During the calving season, elk use was proportional to availability for all distance categories. The interval from 1.0 to 1.5 miles received the most elk use. During the summer season, use was significantly less than availability for areas less than 0.5 miles (0.8 km) from disturbance and significantly greater than availability for the interval from 1.0 to 1.5 miles (1.6-2.4 km). Results for the rutting season were similar to

Table 28. Percentages of availability and elk use related to study area habitat types, 1980.

Habitat types	N	% Availability 300	% Elk Use Calving 74	Summer 163	Rut 113	Hunt 88	Total 438
Dry meadow		1.3	1.4	1.2	2.7	1.1	1.6
Wet meadow		0.7	0.0	0.6	0.0	1.1	0.5
Pasture-hayfield		6.3	--0.0	--0.0	-0.9	--0.0	-0.2
North slope clearcut		2.7	9.5	1.2	0.9	1.1	2.5
Road		2.0	1.4	3.1	0.9	0.0	1.6
PSME/Bunchgrass		5.7	1.4	--0.0	--0.0	6.8	1.6
PSEM/VACA		13.0	--1.4	7.4	6.2	6.8	-5.9
PSMA/PHMA		2.3	10.8	5.5	5.3	5.7	6.4
PSME/VAGL		1.3	5.5	0.6	2.7	2.3	2.3
PSME/LIBO		10.7	10.8	11.0	12.4	6.8	10.5
PSME/SYAL		18.0	12.2	14.1	14.2	9.1	12.8
PSME/CARU		8.7	23.0	++26.4	10.6	14.8	++19.4
ABLA/CACA		2.7	0.0	0.0	0.9	2.3	0.7
ABLA/LIBO		4.3	12.2	7.4	10.6	+17.0	++11.0
ABLA/MEFE		11.3	4.1	-3.7	11.5	12.5	7.5
ABLA/XETE-VAGL		6.7	4.1	9.2	12.4	--0.0	7.3
ABLA/XETE-VASC		0.3	1.4	+6.1	5.3	+11.4	++6.2
Other		1.9	1.4	2.5	2.7	1.1	2.0

those of the summer season with use significantly less than availability for the 1.0 to 1.5 mile (1.6-2.4 km) interval. There was a shift to proportionally less use within the 0.5 to 1.0 mile (0.8-1.6 km) interval. Use during the hunting season was proportional to availability except for the last two intervals. The interval from 1.5 to 2.0 miles (2.4-3.2 km) received significantly less use than availability, the interval greater than 2.0 miles (3.2 km) received greater use.

Table 29. Percentages of availability and elk use related to logging and road building activities in the study area, 1980.

Distance to activity in miles	N	Calving Avail. 300	Calving Use 74	Summer Avail. 300	Summer Use 163	Rut Avail. 300	Rut Use 113	Hunt Avail. 300	Hunt Use 88
0.0-0.5		13.8	17.6	27.9	--13.5	24.4	-12.4	11.0	14.8
0.5-1.0		20.7	14.9	24.6	25.8	29.8	22.1	21.9	18.2
1.0-1.5		29.2	35.1	25.9	+38.0	23.4	+34.5	25.2	21.6
1.5-2.0		22.6	13.5	11.3	14.7	12.4	23.9	23.6	--9.1
>2.0		13.8	18.9	10.3	8.0	10.0	7.1	18.3	++36.4

Distance to new roads in the CSA was also measured for each location. Locations that were on the opposite side of a major ridge from the new roads within the CSA were removed from this analysis. This method places greater emphasis upon elk locations within the main ridge system surrounding the CSA in respect to new roads. All locations were then analyzed in respect to their position within or outside this ridge system. In respect to the latter analysis, 44% of the study area is available within this major ridge system. Use was proportional to availability for the calving and hunting seasons. However, use outside the ridge system was significantly greater than availability for summer (+), rut (++) and for all seasons combined (+). Locations within the major ridge system are shown in Table 30. During the calving season, use was significantly less than availability for the intervals from 0-150 yards (0-140 m) and 550-950 yards (500-870 m) and significantly greater than availability for areas greater than 1350 yards (1230 m) from a new road. During the summer seasons, all areas less than 950 yards (870 m) from a new road were used significantly less than availability. The areas greater than 1350 yards (1230 m) were used significantly more than available. For the rutting season, use was again significantly greater than availability for the areas farthest from new roads and less than availability for the 550-950 yard (500-870 m) interval. During the hunting season, use was proportional to availability for all categories except the interval from 150 to 550 yards (140-500 m) in which use significantly exceeded availability. For all seasons combined, use was significantly less than availability for the intervals from 0 to 150 yards (0-140 m) and 550 to 950 yards (500-870 m) and significantly greater than availability for the areas more than 1350 yards (1230 m) from a new road.

Table 30. Percentages of availability and elk use related to distance to new roads in the CSA, 1980.

Distance to new road in yards (meters)	% Availability N 132	% Elk Use Calving 32	Summer 53	Rut 30	Hunt 34	Total 149
0-150 (0-140)	15.9	--0.0	--1.9	6.7	8.8	--4.0
150-550 (140-500)	21.2	21.9	--3.8	23.3	+47.1	21.5
550-950 (500-870)	47.7	--15.6	--5.7	--3.3	26.5	--12.1
950-1350 (870-1230)	13.6	15.6	22.6	13.3	5.9	15.4
>1350 (>1230)	15.0	++46.9	++66.0	++53.3	11.8	++47.0

Vehicular use on the majority of the open roads within the study area was light (less than 1 vehicle trip/day) during 1980. However, several roads associated with the logging and road construction activities mentioned previously received heavy (5-9 vehicle trips/day) traffic. The East Fork of Chemberlain Creek received heavy traffic throughout the year. The first half mile of the West Fork of Chamberlain Creek road received heavy traffic from calving to the start of hunting season. The main Chamberlain Creek road within the CSA received heavy use from the

middle of July through hunting season. On the west side of the study area, the Fish Creek haul road received heavy use from calving season up to hunting season. In addition to these roads, the main haul road connecting Bear Creek with the Fish Creek haul road was heavily used from mid-summer to hunting season. Table 31 shows the distribution of elk locations with respect to open roads. During all seasons, areas within 150 yards (140 m) of open roads are used significantly less than their availability. The reverse is true for areas greater than 1350 yards (1230 m) from open roads for all seasons. During the summer season, use also significantly exceeded availability for areas between 950 yards (870 m) and 1350 yards (1230 m).

Table 31. Percentages of availability and elk use related to distance to open roads, 1980.

Distance to open roads	Calving		Summer		Rut		Hunt	
in yards (meters)	Avail. N 300	Use 74	Avail. 300	Use 163	Avail. 300	Use 113	Avail. 300	Use 87
0-150 (0-140)	41.1	--14.9	54.6	--20.2	54.6	--13.3	27.6	-3.4
150-550 (140-500)	37.6	32.4	32.0	40.5	32.0	23.0	29.3	19.5
550-950 (500-870)	12.0	12.2	8.9	14.1	8.9	8.0	27.7	21.8
950-1350 (870-1230)	7.0	6.8	3.4	++17.8	3.4	9.7	14.5	10.3
>1350 (>1230)	2.3	++33.8	1.1	+7.4	1.1	++46.0	1.4	++44.8

Elk use of the study area as related to logging history is presented in Table 32. The majority of locations except during the calving season occurred in areas that are unlogged or logged more than 30 years ago. However, these values approximated availability except during the hunting season in which significantly more use was made of unlogged areas. Non-forested areas were consistently used significantly less than availability. The only other significantly different use pattern occurred during the calving season, during which elk made more use of areas cut in the last decade.

Table 32. Percentages of availability and elk use related to logged areas, 1980.

Time of logging	% Availability N 300	% Elk Use Calving 74	Summer 162	Rut 113	Hunt 88	Total 437
1970-1980	14.0	++28.4	20.4	12.4	13.6	18.3
1960-1969	8.7	23.0	9.3	7.1	3.4	9.8
1950-1959	6.0	4.1	3.1	9.7	6.8	5.7
Pre-1949	34.4	24.3	40.7	35.4	27.3	33.9
Unlogged	27.3	18.9	26.5	34.5	++46.6	31.4
Non-forested	9.7	--1.4	--0.0	--0.9	--2.3	--0.9

Relative Hunter Use and Elk Harvest

The study area is in Hunting District 292. It is also largely within the Blackfoot Special Management Area (BSMA), where roads are closed to public vehicular access from 1 September through 1 December. Either sex archery hunting for elk was allowed in the area from 6 September through 12 October 1981. Also, there was a general hunting season for antler males and for either sex by permit only from 19 October through 30 November. The number of either sex permits remained at 75 in 1980, and they were valid only in the eastern part of H.D. 292.

The total number of hunters checked at the Bonner check station increased 25%, from 4879 in 1979 and 4876 in 1978, to 6012 in 1980 (Hartkorn 1980). This check station serves a much wider area than H.D. 292, but results from the station show the hunting trends for the general area. The known number of elk harvested in and near the BSMA increased 50% from 50 animals per year in 1978 and 1979, to 75 in 1980. Forty-three of the elk taken during 1980 were killed within the BSMA, and 32 were from nearby surrounding areas. Only one elk, a female, was taken during the archery season. Forty-three (58%) of the elk harvested in 1980 were males (21 spikes and 22 branch-antlered), 25 (33%) were females, and 7 (9%) were calves.

DISCUSSION

Five years of pellet count data on all transects in the core study area (CSA) have now been acquired. Even though the levels of human disturbance in the CSA have increased since 1978, many of our early results and conclusions based on pre-disturbance data (Scott 1978, and Marcum et al. 1979) are still valid after including the 1980 data. A

combination of weather and vegetative composition, structure, and phenology are still the primary factors influencing habitat use patterns by elk in the CSA, as well as total use of the CSA. Though not necessarily a cause and effect relationship, we continue to show a very high correlation between precipitation and elk use of the CSA. None of the habitat components have been preferred throughout all years and seasons, but elk continue to make almost universal use of the available habitats in the CSA. However, elk use has been consistently less than availability on areas greater than 450 yards (410 m) from water, small diameter lodgepole pine stands (pole-sapling successional stage), and primary upper slopes and ridgetops. Except during the fall and the spring of wet years (1978 and 1980), elk use of steep slopes (>30°) has also been less than availability.

Fall elk use in the CSA has been evaluated since 1978 by using the OVO pellet count from the following spring. Elk use during fall 1979 was over twice the fall 1978 use. Fall 1979 was unusually warm and dry. In normal years elk are more attracted to relatively xeric sites, largely outside the CSA, by late September or early October. Though the level of use changed, the patterns of elk use of the CSA during fall months of 1978 and 1979 were similar and not highly selective. Use was greatest at elevations of 5700-6200 feet (1740-1890 m), on gentle (0-15°) mid-slopes or secondary upper slopes and ridges, and on westerly aspects. Use during both falls was significantly greater than availability for bunchgrass understories, and significantly less than availability for understories dominated by grouse wortleberry. However, the use of dense tree stands and old successional stages was greater during fall 1979 than during fall 1978. Generally, it appears that elk may be less vulnerable to hunters during years when the fall months are warmer and drier than normal.

During the springs of 1980 and 1978, which were relatively wet, elk preferred northern subunits at lower elevations (<5700 feet, 1740 m), moderate to steep slopes (16-38°), and old stands of large Douglas-fir in Douglas-fir habitat types with more xeric understory species. Conversely, during the very dry spring of 1977, southern CSA subunits at higher elevations (>5700 feet, 1740 m), gentle slopes (0-15°), and young stands of medium to large lodgepole pine in subalpine fir habitat types with mesic understory species were preferred by elk. Spring 1979 was slightly dry, and the amount and patterns of habitat use by elk in the CSA were intermediate to those of 1977 as compared to 1978 and 1980. Also, habitat use patterns by elk in spring months are more selective during wet years than dry ones. Although influenced by sample size, spring elk use was significantly different from availability for 26 habitat components in 1978 and 34 in 1980, as compared to 10 and 16 for the dry years of 1979 and 1977 respectively. Spring habitat use by elk in the CSA was similar during all 4 years considered for some habitat components. Use was always greater than availability on areas with less than 25% overstory canopy cover, including clearings; sight

distances of greater than 100 yards (91 m); and old successional stages. Use was always less than availability for areas greater than 450 yards (410 m) from water and areas with the understory dominated by grouse whortleberry.

The summer 1980 pellet count data support the results and conclusions presented previously (Scott 1978, Marcum et al. 1979 and 1980). From spring to summer, elk use tends to increase in more mesic habitats at higher elevations. However, habitat use in the CSA during moist summers may be similar to use during wet springs, except for the increased summer use of areas with greater overstory canopy coverage. During years when precipitation was greater than normal such as 1976, 1978 and 1980, and even somewhat drier than normal as during 1979, there was relatively less selectivity of the various habitat components in summer. During these years, the number of cases that summer use of habitat components by elk in the CSA differed significantly from availability ranged from only 8 to 12. In contrast, during the drought year of 1977, 46 significant differences were recorded in summer. Also, this differs from the spring results, discussed above, in that spring habitat selectivity by Chamberlain Creek elk is greater during wet years.

In many ways, the patterns of summer habitat use by elk in the CSA have been similar for all years. This is especially true for categories of elevation, slope, aspect, topography, and distance to water. But, it is also true for many of the vegetative habitat categories. The greatest variations in summer use of the CSA were in the total amount of use, and in the relative selectivity of mesic plant communites. In dry years elk move to wet areas in the CSA earlier, and stay longer. This was especially evident during the very dry summer of 1977. Summer elk use of the CSA in 1977 was approximately 3 times greater than summer use during the wettest years of 1976 and 1980. Precipitation during 1978 and 1979 was intermediate to these extremes. Summer 1978 and 1979 elk use was similarly intermediate to use during the wetter and drier years. Elk in the CSA have demonstrated great adaptability in their use of available habitat to yearly changes in environmental conditions. However, during very dry years their options are much reduced, so they are then more vulnerable to disturbance.

There were no road building or logging activities in the CSA during the 1976 and 1977 seasons, only low levels of intermittent road building during 1978 and 1979, and moderate levels of activity, both roading and logging, during 1980. Last year we reported that pellet count results indicated that elk avoided areas within 150 yards (140 m) of new roads in the CSA during all three seasons (Marcum and Lehmkuhl 1980). Although disturbance in the area increased, we did not detect avoidance of areas near new roads by elk this year using the pellet count technique. Since pellet deposition is relatively constant and disturbance is relatively intermittent, this does not mean that the animals are not avoiding the actual disturbance. Telemetry results for 1981 indicate that areas within 150 yards (140 m) of new roads were avoided. Future results will clarify this relationship. Though areas near roads may be avoided by elk, we have detected no avoidance of

the subunits where most of roading and logging activity has occurred. In fact, except for summer 1980, elk use has been significantly greater than availability in the most disturbed subunit (8) during all seasons for the last two years. Elk use of the entire CSA during summer 1980 was somewhat less than we would expect, using precipitation-elk use regression model from last year. However, we did not detect any avoidance by elk of areas where road building and logging activities were greatest, and the correlation between precipitation and elk use was still high after adding the 1980 data. Thus, it does not now appear, that given these levels of roading and logging activities, elk avoided the CSA during 1980 because of human disturbance. As in past years, apparent avoidance of old logged areas and roads by elk could be attributed to other factors of habitat selection, and no distinct patterns of elk distribution with respect to planned logging areas or roads were observed.

As noted previously, the correlation between precipitation and elk use remains high after adding the 1980 pellet count data. We have hypothesized that this relationship is a result of direct weather effects; and indirect effects of weather on forage quality and quantity, both inside and outside the CSA (Marcum et al. 1979). Regardless of the cause-and-effect relationship though, this remains our most valuable tool for evaluation the influence of disturbance on total elk use of the CSA.

Telemetry results for the 1977, 1978 and 1979 field seasons were discussed in previous annual reports and by Lehmkuhl (1981). Use of the CSA by radio-collared elk was relatively less in 1980 than during previous years. However, this pattern of low use was predicted on the basis of annual precipitation (Marcum et al. 1980). The 1980 field season was the wettest season for which telemetry data were recorded. The CSA, which contains a large portion of the high elevation mesic sites within the study area, experiences increasing use with decreasing annual precipitation. Use of the CSA was not significantly different than its availability during the wet 1980 field season. Use of the CSA was significantly greater ($p<0.01$) than availability for the preceeding years. Use increased from a moderate level during 1978, a moist year, to a very high level during 1977, an extremely dry year. This trend was most evident during the calving and summer seasons in which a large portion of the precipitation fell. Use during 1980 was the lowest for all four field seasons during these two seasons. Precipitation during the rutting and hunting seasons was approximately normal, with use adjusting accordingly. For the rutting season, use of the CSA was the lowest in 1978, followed by 1980 and 1977. Only during the rut of 1979 did the use of the CSA significantly exceed availability ($0.01<p<0.05$). Use during the hunting season followed a similar pattern, with 1978 as lowest followed by 1977 and 1980. Use was highest during the dry year of 1979 but significantly exceeded availability ($p<0.01$) for both 1979 and 1980. As the CSA contains the most continuous, heavy cover and is best insulated against hunter access, this increase in use is probably explained by hunter pressure.

Values for seasonal distribution and movement statistics varied from year to year. Values for mean and maximum distances between successive locations for the 1980 calving season were intermediate to high values for 1979 and low values for 1978. Home range area during the 1980 calving season was the highest value for the four years with 1978 being the lowest. The 1980 summer movement and area statistics were all intermediate between high values in 1978 and low values in 1977 and except for home range area, were larger than the 1979 values. The mean distance moved between successive locations during the 1980 rut was the highest value of all four years. The maximum movement for this season was the smallest of all four years compared to the high in 1977. The home range area for the 1980 rut was intermediate between a low in 1979 and a high in 1977. All home range and movement statistics for the 1980 hunting season were the highest observed throughout the four years. The lowest home range value for this season occurred in 1978. Maximum distance moved during the hunt was lowest for 1977, and mean distances were lowest for 1977 and 1978. When considering all locations from May to December for the four years, all movement and home range statistics were highest during 1977 and lowest during 1980.

Yearly differences in home range and movement statistics are probably a function of weather, forage availability, disturbance and hunter pressure. For the calving, rut and all seasons combined, the pattern may best be explained on the basis of differences in yearly precipitation. In general, home ranges and movements were largest in the dry year of 1977. These dry conditions probably affected plant communities, causing them to mature earlier. This would affect forage availability and hence require elk to range further. A reversal of this trend occurred during the summer season of 1977, for which the lowest home range and movements were recorded. A large majority of locations (79.9%) for that period were above 5700 feet in elevation, an area which comprises only 19.9% of the study area. The majority of preferred forage probably fell within these higher elevation areas, and hence limited animal movements. The trend for hunting seasons has been one of general increase of home range and movement statistics over the four years of study. Hunting pressure in this area has followed a similar trend. This trend alone probably accounts for this pattern. However, during the 1980 hunting season, two units were being logged on the east side of Chamberlain drainage and road construction was underway on the west side of the drainage. A combination of factors including hunter pressure, hunter camps, disturbance and elk habituating to safety zones probably accounted for the 1980 home range and movement statistics during the hunting season being much larger than previous values.

The 1980 season again reaffirms the disproportionate use of the CSA by the two trap-site groups. For all four years, the Grace's Landing group consistently used the CSA more than the Lindbergh-Potter group. Excluding one location, very little overlap occurred between the two composite home range groups. Future logging activities within the CSA

will probably impact the Grace's Landing animals to a greater extent than the Lindbergh-Potter animals.

Individual and composite home ranges and movement statistics for elk vary for different study areas. The composite May to December home range of all Chamberlain elk has been between 70-100 miles^2 (182-260 km^2) over the past four years. Since this area includes the winter range used by the study animals, it may be considered a year-round home range. Lonner (1980) reported a year-round composite home range for 36 animals of 685 miles^2 (1781 km^2). A composite year-round home range for 9 elk in the Madison Valley was 568 miles^2 (1471 km^2) (Cada 1978). Seasonal averages of home range, movement statistics and standard diameters reported by Lonner were consistently larger than those found in this study. Craighead et al. (1973) reported average home ranges for 11 elk in Yellowstone National Park that were smaller year-round but seasonally larger for spring and summer-fall than for Chamberlain elk. These authors also report a general increase in seasonal home ranges from spring to fall as was found in this study. Pedersen et al.(1980) report a mean composite home range of 21.5 miles^2 (28 km^2) for adult female elk on a summer range in the Blue Mountains of Oregon. Considering the difference in composite home ranges for Lindbergh-Potter and Grace's Landing animals of this study, the differences between the Chamberlain Creek study and the last two cited are relatively small. The large discrepancies in composite home ranges is best explained by the migratory tradition of the elk in the other studies (i.e., Lonner and Cada) (Knight 1980). Differences in average home ranges and movements of individual elk is probably a function of differences in habitat from one study area to another.

Habitat utilization by radio-collared elk from May to December was quite variable from 1977 through 1980. However, a number of patterns are apparent with respect to some variables. Radio-collared elk consistently avoided (use significantly less than availability) the lower elevations between 3800 and 4400 feet (1160-1340 m). The majority of locations for the four years fell between 4500 and 6200 feet (1370-1890 m). During 1977, 1978, and 1979, elevations between 5700 and 6200 feet (1740-1890 m) were used in excess of availability ($p<0.01$). The next lower elevations (5100-5600 feet; 1550-1700 m) were used in excess of availability ($p<0.01$) for the 1978, 1979, and 1980 field seasons. Use of slope positions was quite variable. This may be partly due to the subjective nature of position classification, especially with respect to what constitutes a drainage head. Analyses from previous years considered the drainage head classification to be more limited than did the analysis for this year. However, ridge tops and mid to upper slopes account for the majority of locations. Lower slopes were consistently used less than availability ($p<0.01$). In respect to steepness of slope, the majority of locations as well as availability were between 0-15^o, but use was significantly different from availability only twice during the four years. During the 1979 and 1980 field seasons, slopes of less than 15^o were used in excess of

availability ($p<0.01$). The apparent discrepancy between elk preference for gentle slopes and avoidance of level aspects is explained by the fact that the majority of level sites are low elevation pasture-hayfields. Topographic configuration varied from year to year. Use was significantly less than availability on straight topography during 1977, 1978, and 1980. Use was significantly greater than availability on concave slopes for two years: 1977 and 1978. Use of convex and undulating slopes generally approximated availability. Distance from water generally had little effect on elk distribution. Areas greater than 550 yards (550 m) from water were used significantly in excess of availability except during the drought year of 1977. Areas less than 150 yards (140 m) from water were generally used less than their availability. Significantly less use occurred for the 0-50 yard (0-45 m) interval in 1980 and for the 50-150 yard (45-140 m) interval during 1977 and 1979. These topographic factors suggest that from May to December, elk tend to prefer higher elevations, particularly ridge tops, mid- and upper-slopes. Except during drought years, close proximity to water does not appear to be a major factor for Chamberlain elk, probably due to general mesic conditions of the study area.

Distribution of radio-collared elk with respect to vegetative factors showed a few patterns for the May to December period. Use was less than availability ($p<0.05$) in open sites during 1978 and 1979. Otherwise, elk use by overstory canopy coverage class did not vary significantly from availability. Habitat age and composition showed some general trends. Mixed species stands from pole to mature size were consistently used in excess of availability but not significantly. Dense lodgepole stands were consistently used less than availability. The pasture-hayfield habitat classification was avoided by elk ($p<0.01$) for all four years. In respect to Montana Forest habitat types, the following patterns were noted. PSME/Bunchgrass types were consistently used less than availability. PSME/VACA and PSME/SYAL types were also used consistently less than availability, the former significantly so during 1977, 1979, and 1980, and the latter during 1977 and 1979. PSME/CARU, ABLA/LIBO and ABLA/XETE-VAGL types were always used in excess of availability. With respect to vegetative factors year-round, Chamberlain elk seem to prefer the higher elevation mesic sites with a very general preference for mixed species stands of greater than 25% canopy coverage.

Habitat utilization by radio elk on a seasonal basis is also highly variable from year to year, but some patterns emerge. Seasonal elk use of the study area in respect to elevation shows strong patterns. During the calving and all other seasons except the rut, areas between 3800 feet (1160 m) and 4400 feet (1340 m) are used less than availability ($p<0.01$). During calving season, there is a strong preference ($p<0.01$) for mid-elevations (5100-5600 feet; 1550-1700 m) for all years. This preference shifts to the 5700-6200 feet (1740-1890 m) interval during the summer season for all years except 1980, which showed significantly greater use in the 4500-5000 feet (1370-1520 m)

interval. No pattern for elevation use is evident during the rut, except for use of higher elevations during the warm dry fall of 1979. A general preference for mid- to higher-elevations during the hunting season is apparent. Neither steepness of slope nor aspect show any seasonal pattern throughout the study. Slope position showed a couple of general patterns which were expressed in the May to December analysis. Lower slopes were consistently avoided ($p<0.01$) during all seasons. Mid- and upper-slopes and ridge tops consistently received the majority of use throughout all seasons, with a general trend from mid-slopes to upper slopes and ridgetops as the seasons progress. Seasonally, distance to water showed no apparent trend. In respect to topographic factors on a seasonal basis, elevation and slope position showed the strongest pattern. With the exception of the rutting season, elk use in general shifts from mid-elevations to higher elevations from calving to hunting season. During the rutting seasons elk were more widely distributed with respect to elevation. Slope position is highly dependent upon elevation and therefore showed a similar trend. The exceptions to this trend occurred during the wet 1980 field season in which slightly lower elevational preference was shown and during the rutting season in which elk were found on a variety of slope positions.

Elk use of vegetative factors from season to season were also quite variable. Habitat use with respect to overstory canopy coverage varied substantially during the calving and summer seasons. During the rut, a general preference was shown for moderate to dense stands with open stands consistently receiving less use than availability. Elk use during the hunting season showed a general shift from moderate to more dense stands from 1977 through 1980. In general, habitat age and species composition trends were described in the May to December analysis with a strong avoidance ($p<0.01$) of pasture-hayfields throughout all seasons and the majority of use occurring in mixed species stands of pole to mature age. A more specific trend was noted during the hunting season in which elk use in dense mixed species stands accounted for the majority of the locations. Habitat utilization as determined by habitat types varied seasonally from year to year. General patterns were evident, but elk use was not significantly different than availability for any habitat type more than once within a particular season with three exceptions. The consistent avoidance of pasture-hayfields has been previously mentioned. Use of PSME/Bunchgrass types was less than availability during the calving season for all years, significantly so during 1977 and 1979. Except for the 1978 rut, PSME/VACA was consistently used less than availability, with significant differences occurring during the 1979 and 1980 calving seasons, and during the summer and hunting seasons of 1977 and 1979. Additional trends generally appear to be related to yearly precipitation patterns. During the drought year of 1977, the more mesic higher elevation habitat types were generally selected throughout that field season. A general shift to higher elevations andwetter habitat types occurred from calving to summer for all years. During the rut for all years, use approximated availability for most habitat types with the majority of locations

occurring in Abies lasiocarpa series. Use during the hunting seasons again demonstrated a general preference for higher elevation habitat types. Seasonal use of vegetative factors were difficult to separate from topographic factors, especially elevation, but three patterns were evident. One, more mesic sites were selected for during dry conditions, more xeric sites were not preferred during wet seasons. Two, little habitat preference occurred with respect to vegetative factors during the rut and three, there appeared to be a preference for more dense stands during the hunting season.

Habitat use as related to disturbance showed several seasonal patterns. Distance to non-road disturbances showed a dual pattern. First, as evidenced by availability values, non-road disturbances have become more prominent within the study area from 1978 to 1980. The 1978 disturbances had little effect on the distribution of elk; use approximated availability for all distance intervals for all seasons. Non-road disturbances during the calving season for all three years showed only one significant value; use less than availability during 1979. These results were probably a function of the distribution of the non-road disturbances which were generally located in areas seldom used by Chamberlain elk during that season. The second pattern was one of general avoidance of non-road disturbances during the summer and rutting seasons of 1979 and 1980. Use was significantly less than availability for areas less than 0.5 miles from a disturbance. In addition, areas more than 2 miles from disturbances were used significantly greater than availability during 1979 and areas between 1.0 and 1.5 miles received more use than availability ($p<0.05$) during 1980.

Due to changes in analysis procedures in 1980, distances to new roads within the CSA cannot be directly compared to previous years until those data are reworked. However, two trends are evident. One, the majority of locations were generally greater than 1350 yards (1230 m) from a new road and two, few locations occurred within the first 150 yards (140 m) of a new road.

Distances to open roads generally had little effect on Chamberlain elk during the calving and summer seasons. This primarily is a function of road usage. During 1977, 1978, and 1979 the majority of roads received light (less than one vehicle trip/day) to moderate (1-4 vehicle trips/day) use. This situation changed in 1980 as a result of the widespread logging and road construction within the study area. Use during the 1980 calving and summer seasons was less than availability ($p<0.01$) for areas less than 150 yards (140 m) from an open road and significantly greater than availability for areas further than 1350 yards (1230 m) from an open road. During the rut and hunting seasons, areas closest to open roads were consistently avoided ($p<0.01$) and areas greater than 1350 yards (1230 m) consistently received more use ($p<0.01$).

Elk use related to logging history followed a general pattern irrespective of season. Non-forested areas were consistently used significantly less than availability throughout all years and seasons.

Uncut areas generally received more use than availability. These values are significantly greater than availability during the summers of 1977, 1978, and 1979, during the rut of 1977 and 1979 and during the hunting season of 1978, 1979, and 1980. A third trend is one of avoidance of areas cut prior to 1949, significantly so during the summers of 1977 and 1978, and during the hunting season of 1977, 1978, and 1979. This avoidance is primarily a function of those areas generally being at lower elevations, which are not used much during summer months and which are relatively near to hunter access points.

The Blackfoot Management Area (BSMA) continues to be a popular hunting area, and use still seems to be increasing. Some cooperators have expressed concern over problems which would arise if hunter use continues to increase in the future. However, no irreconcilable problems have arisen yet. Since the harvest of females was limited, the substantial one year increase in the elk harvest in 1980 was probably not detrimental to the population.

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JOB V-I
ELK GUIDELINES VALIDATION

PROGRESS REPORT FOR THE PERIOD
JANUARY 1, 1980 - DECEMBER 31, 1980

INTRODUCTION

During the summer of 1980 we were able to complete field validation tests of elk habitat guidelines on five study areas in western Montana. The results will be presented as a Master of Science thesis by Thomas A. O'Neil, University of Montana (1981). The following summary of study methods and results has been abstracted from O'Neil's thesis.

Study Methods and Study Areas

The basic study method involved comparison of elk use among three to four adjacent subunits within a total area of at least 5,000 acres. The test hypothesis was that individual subunits of habitat equally available to the same elk would be utilized by elk at the level predicted by the guidelines. Subunits were individually evaluated for cover/forage ratio and for road density. Within each subunit, 5 to 15 miles of belt transects were then sampled to determine elk use. Brief descriptions of each of the five study areas are presented in Table 1, while cover, road, and elk data are summarized in Table 2.

Table 1. Validation study areas, 1980

Area	Location	No. of subunits	Most common habitat type	Elev. range	Average percent slope
				(Feet)	
Skalkaho	Bitterroot NF	4	ABLA/LUHI	7000-8000	35
Petty Creek	Lolo NF	4	PSME/VAGL	3800-6700	51
Blue Mountain	Lolo NF	3	PSME/PHMA	4000-6400	49
Jim Creek	Flathead NF	4	THPL/CLUN	3600-6600	24
Beaver Creek	Kootenai NF	3	TSHE/CLUN	3200-6400	42

Table 2. Cover estimates, road densities, and elk use of subunits

Area and subunit	Range of cover	Road density	Elk pellet groups/acre
	(Percent)		
SKALKAHO			
Falls Creek	43-90	0	180.2
Little Burnt Fork	40-74	0	170.0
Dam Creek	32-59	1.64	104.7
Crooked Creek	9-79	1.05	90.9
PETTY CREEK			
Eds Creek	51-96	0.90	28.0
Johns Creek	56-93	0.65	25.7
Gus Creek	55-100	0.68	24.1
South Fork	30-79	0.52	20.1
BLUE MOUNTAIN			
Woodman Creek	45-64	1.28	15.9
Sleeman Creek	51-81	0.54	15.4
Camp Creek	55-71	1.03	5.3
JIM CREEK			
Piper Crow Creek	61-93	0.36	10.4
Moore Creek	79-99	0.33	9.1
Jim Creek Lookout	60-96	0.18	6.1
Jim Lake	32-56	3.63	1.7
BEAVER CREEK			
Dixie/S. Branch	56-90	1.19	63.7
Green Gulch	38-66	2.79	33.8
Dry Gulch	60-84	1.72	24.1

Cover/Forage Determinations

Initial communications with management biologists showed that C/F ratios are derived using a wide variety of techniques. In general, biologists do not have enough time to complete on-the-ground sampling and must use either aerial photographs or already available photo-interpretation (PI) types. In this study, cover/forage was obtained by (1) on-the-ground subjective judgment of transect samples, (2) conversion of tree/shrub cover estimates taken on transects, (3 and 4) evaluation of PI types, and (5) by dot-grid sampling from aerial photographs. In the two evaluations of PI types, the first method assumed that the "well-stocked" PI types (11, 12, 14, 17) are cover, while all other types are foraging area. In the second method, field samples were utilized to produce the following conversion percentages:

PI type	Definition (stands over 40 feet)	Percent cover
11	Coarse texture, well-stocked	68
12	Coarse texture, medium-stocked	52
14	Fine texture, well-stocked	80
17	Two-storied, well-stocked	64

While none of these five methods can necessarily be considered "correct," any method that produces estimates widely deviant from the on-the-ground samples should be considered questionable. The mean cover-value estimates for the samples from transects were 56 and 59 percent for all 18 subunits. By comparison, the dot grid, in which each point is classified as cover or forage, averaged 80 percent and PI types without conversion averaged 71 percent. Converted PI types produced a mean cover estimate of 51 percent.

Road Densities

Road densities were determined by dividing the combined lengths of all open roads in a subunit by the area of the subunit in sections.

Elk Use of Subunits

Elk use of individual subunits was estimated on pellet group densities sampled from belt transects 4 feet wide. Transect lengths ranged from 4.7 to 14.8 miles within subunits. The average sample was 9.3 miles.

Estimating Elk-Habitat Values

Evaluating elk habitat with the current guidelines involves estimating habitat potential from cover/forage values and habitat effectiveness losses associated with roads. In some guides additional adjustment for livestock use and other factors can be applied, but these were not tested.

The cover/forage ratio (actually, percentage cover) was converted to a numerical estimate of habitat potential using two different methods. For one test we used the several habitat curves specified in the central zone guidelines. In a second test we used a single curve that starts at 50 percent of potential for 100 percent cover, rises to 100 percent of potential at 40 percent cover (40/60), and drops to zero potential with 20 percent cover.

After habitat potential has been determined, there are a number of factors that can prevent full utilization of available habitat by elk. The most important of these is the density of forest roads open to vehicle traffic. Livestock grazing has also been identified as a possible factor, but it was not tested in this study.

Several road density models have been presented in the recent literature. All are based on similar consistent research showing that the area adjacent to an open forest road is less utilized by elk. As road densities increase,

habitat effectiveness declines. Differences among the models appear to depend on the calculation methods used to convert raw data to road densities and, to a lesser degree, on the quality of cover available and the sensitivity to disturbance of the elk population on which the research was done. This study tested the model presented by Lyon (Journal of Forestry, 1979 77(10):658-660) and the Perry and Overly model presented in Agriculture Handbook 553 (1979, page 122).

Combining Habitat Potential and Habitat Effectiveness

For each subunit in a study area, the calculated habitat potential (cover/forage) was reduced to the level of habitat effectiveness indicated by the road density model. Example: A cover/forage potential of 80 percent was only 60 percent effective because of roads. The subunit was judged to be 48 percent effective as elk habitat (0.80 x 0.60 = 0.48).

Using selected combinations of five different methods of determining cover/forage, two methods of converting C/F to habitat potential, and two different road models, at least 12 different estimates of area habitat effectiveness can be calculated for each subunit. In the interest of brevity, table 3 presents only seven: the Central Zone Guidelines estimate and estimates derived from three cover/forage methods and two road models.

Analyses

Evaluation of the predictions in Table 3 involved two different analyses. In the first, the test was to determine which of the various combinations of cover/forage and road models produced the most consistent prediction. In the second, the test was to determine whether the prediction was significantly different than actual use recorded by elk.

Consistency of prediction was evaluated by dividing the area effectiveness estimate for each subunit into pellet group density actually recorded. In effect, this calculation produces an estimate of the 100 percent potential elk use for the subunit. The test hypothethis assumes that predictions from all subunits should be similar. Low variance among estimates indicates consistent prediction, while high variance indicates inconsistency. Standard deviations associated with each of the data sets in all five areas are presented in Table 4.

Table 3. Area effectiveness estimates by cover/forage method and road model[a]

Area and subunit	Central Zone Guidelines	Single C/F curve: Lyon road model % PI	Lyon road model T/S	Lyon road model PI	Perry and Overly model % PI	Perry and Overly model T/S	Perry and Overly model PI
SKALKAHO							
Falls Creek	58	99	99	84	99	99	84
Little Burnt Fork	43	100	99	93	100	99	93
Dam Creek	7	11	12	12	52	57	58
Crooked Creek	15	37	31	37	63	53	63
PETTY CREEK							
Eds Creek	43	55	55	37	66	66	44
Johns Creek	48	65	63	44	69	67	47
Gus Creek	38	58	63	33	64	69	36
South Fork	18	54	67	67	61	75	75
BLUE MOUNTAIN							
Woodman Creek	32	39	37	34	65	63	58
Sleeman Creek	54	72	70	47	85	84	56
Camp Creek	39	50	45	42	77	71	66
JIM CREEK							
Piper Crow Creek	13	80	46	49	78	45	48
Moore Creek	4	57	46	46	56	46	46
Jim Creek Lookout	12	86	50	61	88	51	63
Jim Lake	<1	11	12	12	29	34	33
BEAVER CREEK							
Dixie/S. Branch	36	35	36	27	60	62	47
Green Gulch	9	12	11	7	44	41	28
Dry Gulch	9	12	12	11	59	59	52

[a]O'Neil's interpretation assumes elk use can go to zero. This table assumes a minimum value of 10-15 percent as indicated in the publication by Lyon (1979).

Table 4. Standard deviation among 100 percent estimates of elk use potential

Method	Area				
	Skalkaho	Petty Creek	Blue Mountain	Jim Creek	Beaver Creek
Central Zone Guidelines	589.1	27.0	21.0	195.8	107.7
Single curve and Lyon road model					
Percent PI	380.0	6.8	18.0	4.4	66.0
Tree/shrub	340.6	10.3	18.5	5.2	83.7
PI	326.5	22.3	19.9	5.5	139.9
Single Curve and Perry Overly road model					
Percent PI	27.5	4.7	10.3	5.0	39.0
Tree/shrub	6.4	7.7	10.5	8.9	37.0
PI	34.5	19.6	11.6	8.0	53.0

Among the seven cover/forage and road model combinations presented in this table, the most consistent results were obtained using cover/forage ratios derived from converted PI types, a single curve for C/F potential, and the Perry and Overly road model. On some study areas other combinations were slightly better, but for all five areas this combination appeared to be the most reliable.

Differences between predicted elk use and actual elk use of individual subunits were tested using the Kolmogorov-Smirnov two-sample test. Under the test hypothesis, no significant difference between predicted elk use and actual use was expected. Data for percent PI, a single C/F curve, and the Perry and Overly model are presented in Table 5.

Table 5. Elk pellet group densities, densities predicted by using percent PI types, a single C/F curve, and the Perry and Overly road model

Area		Subunit data			
Skalkaho	Elk use	90.9	104.7	170.0	180.2
	Predicted	109.1	90.4	174.0	172.3
	χ^2 = 1.22, Probability: 0.55				
Petty Creek	Elk use	20.1	24.1	25.7	28.0
	Predicted	23.0	23.9	26.2	24.8
	χ^2 = 0.21, Probability: 0.90				
Blue Mountain[a]	Elk use	5.3	15.4	15.9	
	Predicted	12.4	13.7	10.5	
	χ^2 = 2.76, Probability: 0.21				
Jim Creek	Elk use	1.7	6.1	9.1	10.4
	Predicted	3.1	9.6	6.1	8.5
	χ^2 = 1.78, Probability: 0.42				
Beaver Creek	Elk use	24.1	33.8	63.7	
	Predicted	44.2	32.9	44.5	
	χ^2 = 6.66, Probability: 0.04 (revalued to 0.20; see text)				

[a]In the Blue Mountain study area, timber sale activity caused a shift in elk use between two of the subunits, but the shift was not great enough to cause a significant deviation from predicted use.

For four of the five study areas, predicted elk use of subunits was not significantly different than elk use actually measured. In the Beaver Creek study area, however, elk use of one subunit was significantly higher than predicted. Within this subunit we detected a topographic gradient over which elk use increased from 36 pga at 5,500 feet to over 95 pga at 4,500 feet. While the reason for this gradient was not clear, comparison of the three Beaver Creek subunits shows that two transects in the Dixie/South Branch subunit were topographically much different than all other transects in the study area. When the analysis is restructured to evaluate only the topographically comparable parts of subunits, elk use was not significantly different than predicted.

Discussion

In this study it was only possible to evaluate a few of the methods used for determination of cover/forage ratios. Additional road models are also being developed and will be evaluated.

This apparent proliferation of variations on the elk guidelines should not obscure the main finding of the study. Despite variations in precision, all of the techniques discussed in this report will predict elk use with fair accuracy. As additional studies are completed, both accuracy and precision can be expected to further improve.

Conclusion

Individual subunits of habitat equally available to the same elk are utilized by elk at the level predicted by the elk habitat guidelines.

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